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Brasília:

Fragmented metropolis

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Abstract

This paper deals with morphological and land use patterns in Brasília Metropolitan Area (BMA). Previous studies concentrated on the morphological attributes of the municipality of Brasília. Now we extend the scale to the metropolitan level. Special softwares are used (Depthmap© and ArcGis©), which allow us to reveal important attributes of the phenomenon: the fragmented and dispersed urban structure; low densities; the eccentricity of the metropolitan centre; severe problems of accessibility among places of residence, work and services etc. The results obtained and the comparison with other Brazilian metropolitan regions allow a critical analysis of the governmental proposals contained in the Master Plan for the Territorial Organization of the Federal District and the Plan for the Preservation of Brasília as a World Cultural Heritage Site. Current trends point to the aggravation of problems, due to the priority granted to urban development in areas far away from the metropolitan core, thus ignoring possibilities for creating new boroughs within the perimeter of the classified area and its immediate surroundings.

Keywords

Brasília, metropolis, urban configuration, urban sprawl, urban mobility.

1. Introduction

We explore relations among constituent parts of the metropolitan urban system that has the municipality of Brasília as its core, that is, the Brasília Metropolitan Area (BMA). As far as morphological properties are concerned, the metropolitan configuration is analysed in terms of its fragmentation; the deployment of people in space (demographic densities); the position of the metropolitan core; the localization of houses, jobs and services among themselves. In terms of the social implications of such properties, we explore costs involved in such configuration, considering its impact on mobility and on deployment of social classes in space, thus implying patterns of social appropriation of places.

The Brazilian Capital has evolved as a middle class city, in the image of the federal bureaucracy that it houses. This characterizes both the core and its “satellite nuclei”. The core is the “Pilot Plan” and its immediate surroundings – the originally planned bit of the present system; the “satellite nuclei” are dormitory quarters rather than actual cities, for, mostly, they lack the appropriate number of jobs and services. (There is a confusing denomination: the Federal District, which has also the *status* of a unit of the Brazilian federation as any other state, coincides with the official *municipality of Brasília*, but “Brasília” is also the *Administrative Region 1*, the metropolitan core, much smaller than the municipality in which it is located. For the sake of clarity, we will not refer henceforth to the Federal District, only to the municipality of Brasília, for both denominations refer to the same territory.)

Even today, 55 years after inauguration, the metropolis is highly peculiar, when compared with other Brazilian counterparts. Comparative studies classify the latter in five groups; Brasília is the only one in “type 2”: it is a city of services (59.7% of the economic activities), whereas the others present, in average, 43.6% in the tertiary sector of the economy. On the other hand, 8.7% are industrial activities, when, in the other groups, the minimum is 27.9% (as in the paper by Ribeiro and Ribeiro, 2010). However, the latter study exemplifies one of two trends concerning metropolitan studies in Brazil, those that are concerned with socio-economic attributes that are mostly a-spatial. The second deals with configurational aspects, as in the studies by Rigatti and Ugalde (2007), but, in turn, they largely lack socio-economic aspects. In this paper, we attempt to make a bridge between the two approaches. We show that, if the BMA is socio-economically peculiar, it is highly peculiar morphologically as well.

No research had so far examined Brasília’s configuration at the metropolitan scale (our own previous studies have focussed on the municipality of Brasília, e.g. Holanda et al., 2008; Holanda, 2011; Holanda and Medeiros, 2012). We now attempt to establish relations among the spatial configuration of the BMA, the deployment of demographic densities in space, and the localization of jobs. Together, these aspects have important implications concerning the welfare of the inhabitants.

2. Theory, method, techniques

Theory

Theory comprises items of knowledge and their relations. In this paper we relate configurational aspects of the BMA and land use patterns, here included demographic densities and localization of jobs and services. For configurational aspects, Space Syntax Theory (SST) stands to the fore. It is a systemic approach towards architectural space in all scales, from, e.g., the domestic to the regional realm. The aim is to depict the spatial structure of the metropolis as a system of inter-related parts, the attributes of which are a function of their insertion in the system as a whole. We shall comment on how the parts of the BMA are more or less integrated to the whole, and how this affects people’s life. Thus, the first analytical moment: to characterise the spatial structure itself.

Urban systems imply movements from house to house and from houses to jobs and services, as well as movements among the latter. The spatial structure, as in the above, strongly conditions such movements. Thus, the second analytical moment: how houses, jobs and services are located

according to the spatial structure, how they are *qualified* spatially. We shall see how *zoning* in Brasília, together with the spatial structure, affects, in particular, relations between home and central functions.

Method

Method comprises analytical categories by which items of knowledge, as in above, are described and related, qualitatively or quantitatively. In this paper, categories include the *integration measure*, coming from SST, by which we quantify the *fragmentation* of the metropolis. Other categories are associated with it: urban residential densities and the number of jobs per spatial unit, resulting in measurable categories as *dispersion* (or urban *sprawl*), and *eccentricity*, which depicts, in the case of the BMA, how peculiarly central functions are related to the city as a whole.

Techniques

Techniques comprises *operational procedures* to carry out the analysis; they are the method's *toolbox*. We are dealing with an area that has *circa* 150km between its extremes. Thus, the focus is on the street grid. The *technique of axiality*, again coming from SST, abstracts the spatial structure of the metropolis in terms of its *axial map*, by which the road grid is represented by straight connected lines. We have built the axial map manually, after digital cartographic information systems of Brasília and the neighbouring State of Goiás. After processed in the software *Depthmap*, lines appear in colours from red to deep blue, representing respectively the most accessible lines and the least accessible ones from the system as a whole. Figure 1 shows the road system for the BMA. We call the *morphological metropolitan core* the set of red lines to the west of the Plan Pilot (the two "wings" of the Pilot Plan are clearly visible in the centre of the illustration). We put the BMA fragmentation into perspective by inserting it into the broader picture of urban realities in Brazil and abroad.

On the other hand, we consider larger or smaller territorial units, as administrative regions or census tracts. We use GIS tools by which we spatialize demographic and employment data in those units, depending on available information. This allows the association between global and local attributes of places, and the homes and jobs therein.

More specific observations on theory, method and techniques will be done along the empirical analysis.

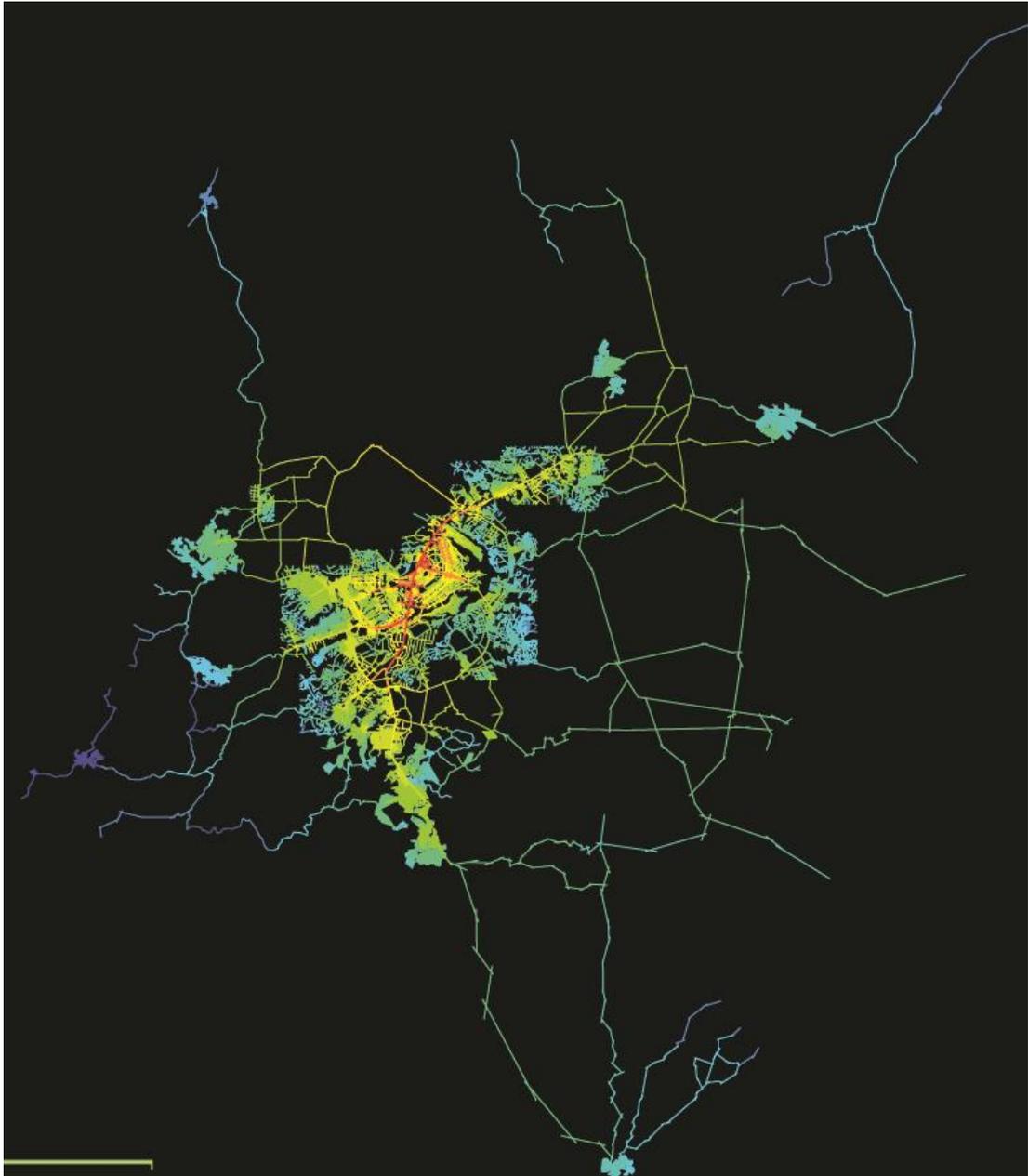


Figure 1: Axial Map of the Brasília Metropolitan Area

2. Fragmentation

The BMA presents, *par excellence*, one of the typical attributes of Brazilian cities, as compared with cities in other parts of the world (North America, Latin America, Europe, Asian and the Pacific Region etc.): its *fragmentation*. This occurs 1) by a continuous urban fabric, although characterized by grids that have different configurations and are not articulated by long axes that trespass them through long distances or 2) by a discontinuous urban fabric with great voids. Brasília, the “patchwork pattern”, as suggested by Medeiros (2013), presents the first or the second case, depending on the area under consideration. In the peripheral metropolitan municipalities the first version predominates: the arrangement of various but continuous grids, particularly in more recent urban expansions. In the metropolitan core – the municipality of Brasília – the second version predominates: it is a *collage* of dispersed parts, separated by huge empty areas. This core is constituted by *Administrative Regions*, to which we shall refer in this paper (Figure 2,

Chart 1).

Considered as a whole, the BMA presents a discontinuous fabric, with large areas separating the urbanized parts. Certainly, there are connurbated parts; we shall see the degree in which this occurs.

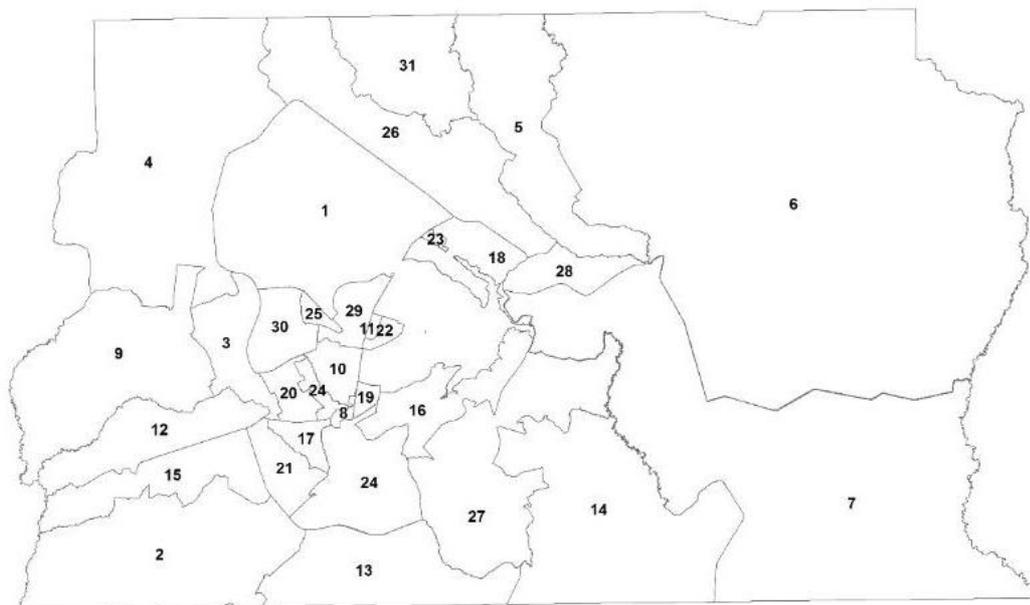


Figure 2: Administrative Regions of the Federal District - Municipality of Brasília (ARs)

Chart 1: Administrative Regions of Federal District

Administrative Regions	Administrative Regions	Administrative Regions
AR I Brasília	AR XII Samambaia	AR XXIII Varjão
AR II Gama	AR XIII Santa Maria	AR XXV SCIA (*)
AR III Taguatinga	AR XIV São Sebastião	AR XXVI Sobradinho II
AR IV Brazlândia	AR XV Recanto das Emas	AR XXVII JardimBotânico
AR V Sobradinho	AR XVI LagoSul	AR XXVIII Itapoã
AR VI Planaltina	AR XVII Riacho Fundo	AR XXIX SIA (**)
AR VII Paranoá	AR XVIII LagoNorte	AR XXX Vicente Pires
AR VIII NucleoBandeirante	AR XIX Candangolândia	AR XXXI Fercal
AR IX Ceilândia	AR XX ÁguasClaras	
AR X Guará	AR XXI Riacho Fundo II	
AR XI Cruzeiro	AR XXII Sudoeste/Octogonal	

(*) Industry and Supply Complementary Sector

(**) Industry and Supply Sector

The “dispersed urbanization”, more commonly known as *urban sprawl*, is an object of increasing attention by researchers (Reis, 2006). In general, however, it has happened after the consolidation of great continuous urban nuclei, and because of diseconomies of agglomeration and other determinations, *e.g.* the political power of the automobile industry (Duany et al, 2000). In Brazil, besides the influence of the car, we have the strong hand of the building industry and land markets (Villça, 2012). However, not in the BMA, particularly in the municipality of Brasília, where State policies have been mainly responsible for dispersion.

Outside Brasília, in what today constitutes a reasonably functional metropolis – *de facto* integrated in terms of jobs and services – there were centenary urban nuclei. Table 1 shows the municipalities and the respective dates of the intensification of territorial occupation or the formal constitution of the municipality.

Table 1: Municipalities of the BMA

Municipality	Origins (*)	Aproximate distance to CBD in km (**)
Luziânia	1746	60
Formosa	1843	82
Cristalina	1880	131
Brasília	1956	0
Padre Bernardo	1957	111
Alexânia	1958	89
Planaltina (Goiás)	1960	60
Cidade Ocidental	1976	50
Valparaíso de Goiás	1979	42
Sto. Antônio do Descoberto	1982	48
Águas Lindas de Goiás	1990	50
Novo Gama	1995	44

(*) In cases prior to 1956, this is the approximate year of the intensification of territorial occupation. In the others, the year concerns the formal constitution of the municipality.

(**) CBD, here understood as the point around which the majority of jobs and services of the metropolis concentrate. This is the crossing of the two structural axes of the Plan Pilot - the Road Axis and the Monumental Axis. Distances refer to the shortest metric route.

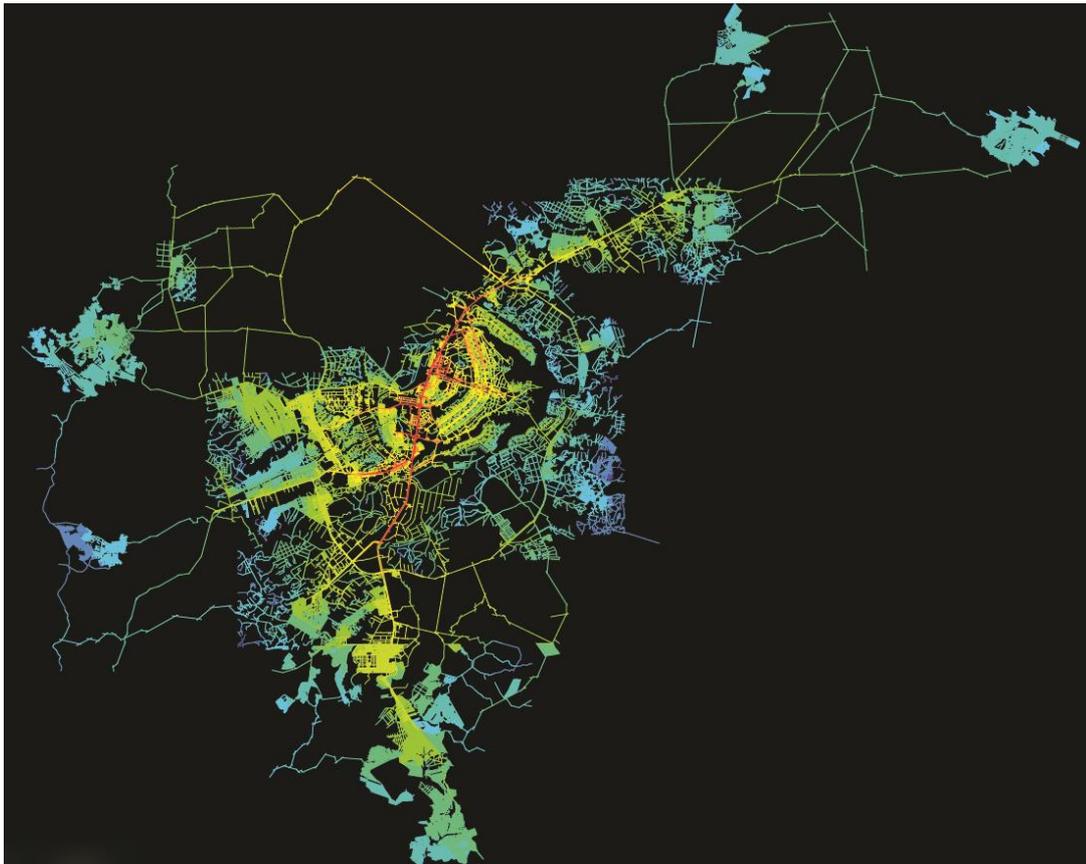
The configuration of such nuclei has attributes that are similar to the ones found within Brasília, in the vernacular settlements that pre-existed the Federal Capital. In the more ancient ones (dating from the 18th Century), the historic centre presents a regular orthogonal grid and clearly defined public spaces; in the more recent ones, we observe fragmentation “type 1”: grids characterized by “patches” which do not dialogue among themselves.

In a great number of cases, housing policies have been responsible for such fragmentation. Public funding housing estates have intensely sprung in urban peripheries in disarticulate fashion, given birth to the “patchwork city”.

Concerning the integration measure, in the broad repertoire studied by Medeiros (2013), he found numbers that vary between 0.182 (the most fragmented, or “deep”, system: Phuket, Thailand) and 2.707 (the “shallowest” system, that is the most topologically accessible system among its parts: Hollywood, U.S.A.). In order to facilitate understanding, we have normalized the values found by Medeiros between '0' and '100': thus, Phuket = 0 and Hollywood = 100. In this normalization, the average accessibility of Medeiros' sample is 29.18; in Brazilian cities, it is 23.21; in the BMA core – Brasília – it is 19.61 (Figure 6); in the BMA as a whole, it is very low: 4.04 (fragmentation illustrated in Figure 1). At least in this morphologic variable, we can hardly consider the area as a cohesive system.

Zooming in from the BMA to the municipalities that are more functionally integrated around Brasília, the topological accessibility goes up, but not very: from 4.04 (BMA) to 4.46 - an increase of only *circa* 10% (Figure 3). However, as there are still isolated nuclei inside Brasília (*e.g.* Brazlândia), we redraw the map for the minimally conurbated area of the metropolis (although there are still discontinuities, Figure 4). Not surprisingly, the area is still very deep: the measure of accessibility rises to just 4.50.

SST measure of accessibility (“integration”) is normalized concerning the size of the system, here understood in terms of the number of lines of the axial map. In Medeiros' sample, the biggest system is São Paulo, Brazil, with about 80,000 axes¹. It is a bit smaller than the conurbated BMA, with little less than 100,000 axes. The measure of accessibility, however, falls drastically from 7.57 (São Paulo) to 4.50 (conurbated BMA). That is to say, São Paulo (Figure 5), where *circa* 10,000,000 inhabitants live, is about 68% more accessible among its constituent parts than the conurbated area of Brasília, where *circa* 2,500,000 inhabitants live.



¹ This is not the axial map of the whole municipality: some sparsely occupied areas to the South have been operationally disconsidered.

Figure 3: Axial map of the BMA, including the cities most functionally related to the metropolitan core

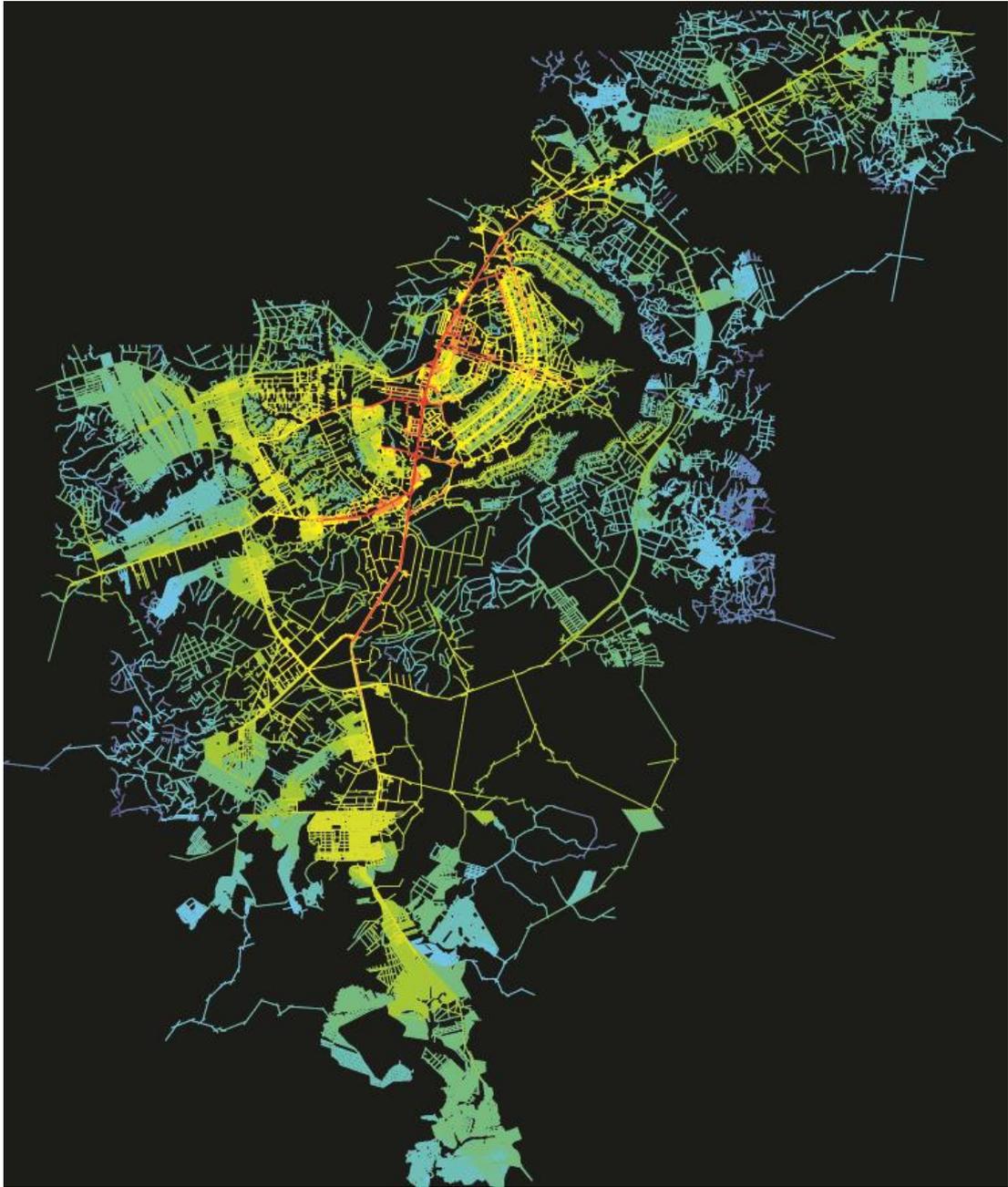


Figure 4: BMA: axial map of the conurbated area

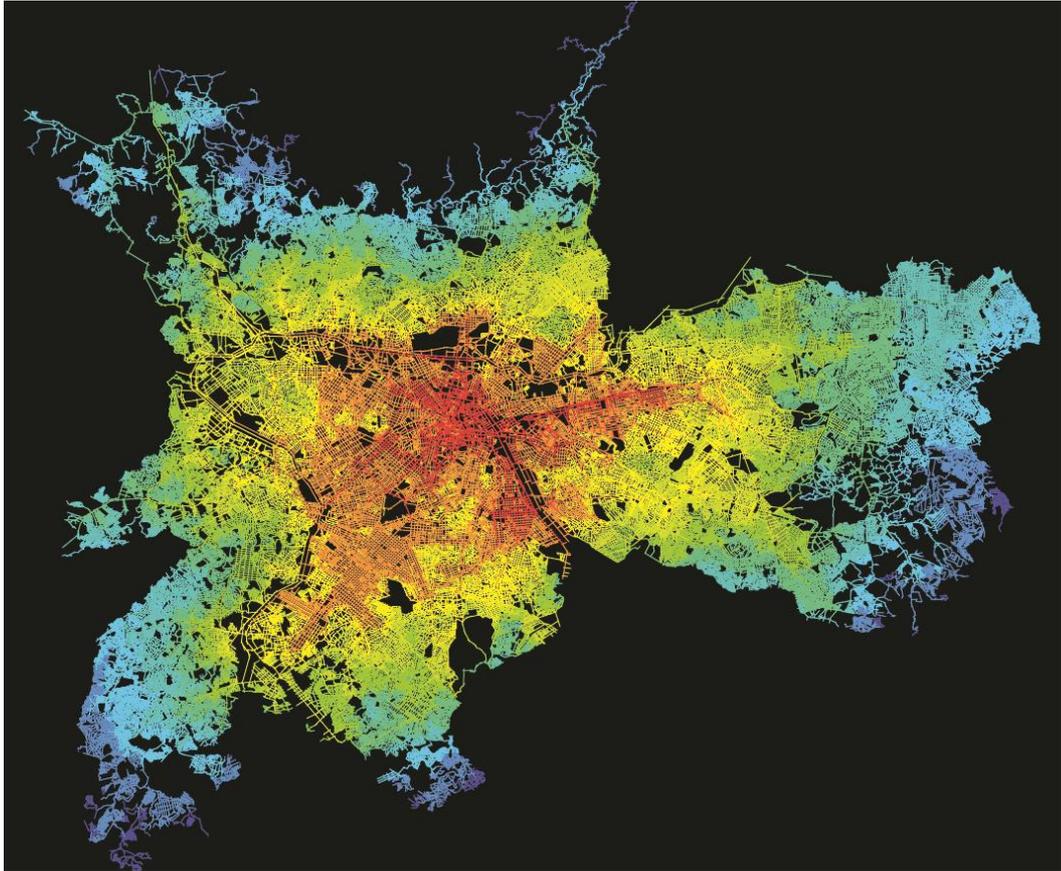


Figure 5: Part of São Paulo axial map

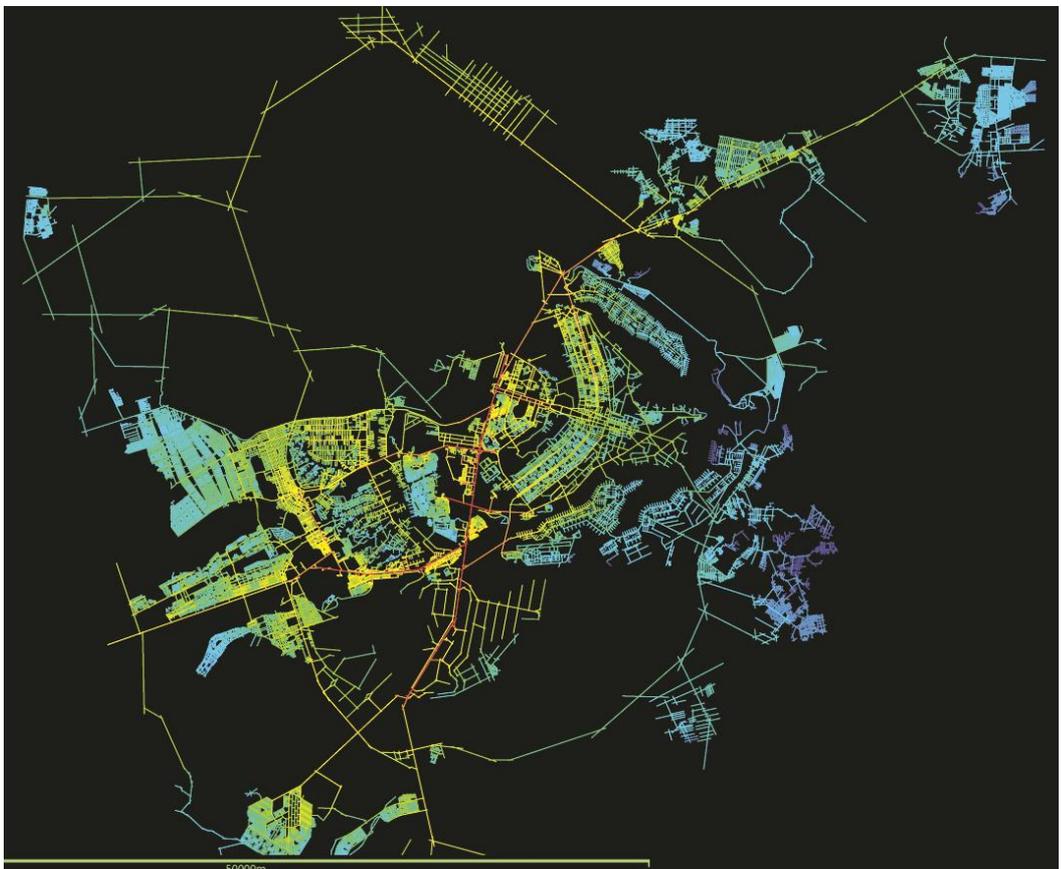


Figure 6: Axial map of the core city of the BMA (Brasília)

The performance of BMA, or, more precisely, the minimally conurbated area, indicates a situation of extreme dependence on few streets/roads to articulate the complete urban system, thus compromising the urban dynamics for the strong restrictions of accessibility that it implies. When we add the aspects of *dispersion*, *density* and *eccentricity*, we have a more complete view of the morphologic problems of this peculiar metropolis.

3. Dispersion

Both the BMA and its core city – Brasília – are strongly discontinuous urban areas. Particularly when compared with other Brazilian metropolises, the sparse spatial structure stands out. However, geographic features inexistent here to produce dispersion – mountains, lakes, bays, irregular sea front – as in Rio de Janeiro or Florianópolis. A simple way to detect dispersion in cities is to calculate the average distance between inhabitants and urban centre. In the case of Brasília, it is 20.2 km. Much bigger cities in population (Jakarta, New York, Los Angeles, London) present smaller distances. With approximately the same population of Brasília, the city of Curitiba, Brazil, for example, presents an average distance to centre almost three times smaller (Table 2).

Table 2: Comparison between population and distance to the centre of 6 cities²

City	Population	distance per capita to centre (km)
Jakarta	14,909,000	17.4
New York	10,753,000	18.3
Los Angeles	9,317,000	23.9
London	6,626,000	12.6
Brasília	1,509,000	20.2
Curitiba	1,644,000	7.7

Source: Bertaud (2001) and Serra et al. (2004).

Bertaud&Malpezzi,³ have proposed a more sophisticated way to measure this: the *dispersion index* compares a real city with a compact hypothetical circular city with the same area and population

²Bertaud, 2001. In another source of the same year the value estimated for Brasília is 24.3 km, for Curitiba is 11.2 km, and for Recife is 13.1 km (Serra et al. (2004)). It is not clear which the sources are for these authors. Analysing the period when it was written it is possible that they did not use the data of the Census 2000 (Brasília = 2,051,146 inhabitants), but of the one from 1991. However, although they are close to each other, the numbers do not coincide with those of the Census 1991 either (Brasília = 1,599,207 inhabitants).

³Bertaud&Malpezzi called the measure 'compactness index' or 'dispersion index'. We have chosen the second one: in the adopted formula, the more dispersed the city, the higher is the value (Bertaud and Malpezzi, 1999). For the sake of clarity, we have adapted the formula to calculate the index and perform a normalization procedure. The formula is :

$$\rho = \frac{\sum_i d_i p_i}{PC}$$

where: 'ρ', the symbol of the Greek letter 'rho' is the dispersion index; 'd' is the distance from the centroid of each urban sector to the city centre; 'p' is the population of each urban sector; 'P' is the total urban population; 'C' is the average distance of the points of a circle with equivalent area to the city analyzed to its centre (value =

(the population uniformly distributed). Comparative studies reveal that Brasília, with a dispersion index of 2,206 (for the year 2000), is the second most dispersed city in the world, losing the place of pride only to Mumbai (India), with 3,080⁴. From 2000 to 2010, dispersion in Brasília has fallen a little, to 1,989.

4. Densities

Demographic densities in the BMA are low, but not extremely so: Brasília is in the inferior third of the decreasing sequence of densities among Brazilian metropolitan regions. From the Census 2000 average density was of 28.52 inhab/ha and went up slightly to 29.84 inhab/ha in 2010 (Figure 7).

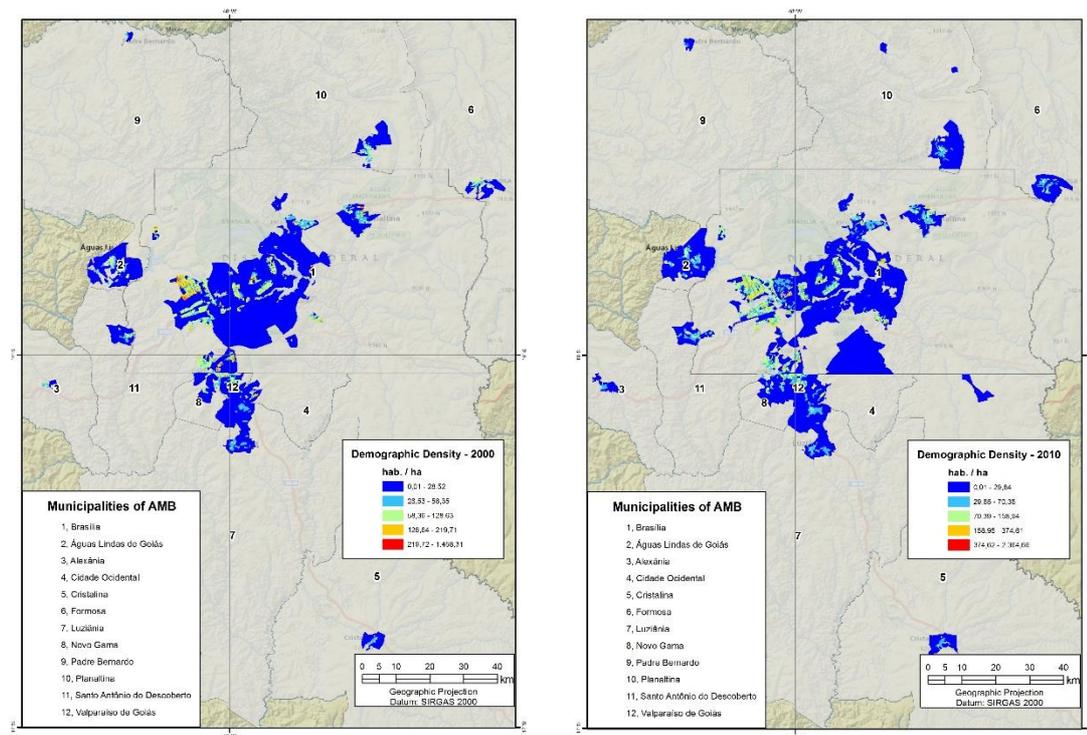


Figure 7: Urban demographic densities

Although below Brazilian average for metropolitan regions in 2010 (45.78 inhab/ha), the density of the BMA is far from the least dense of all, which is Florianópolis, with 19.44 inhab/ha. However, the latter presents strong peculiarities in its natural site, which, by the way, also makes it the Brazilian Capital with the lowest average value in the measure of topological accessibility (seen above as 'fragmentation'). No wonder Florianópolis is the Brazilian city with highest costs of urban infrastructure maintenance (Mancini, 2008). Low densities imply high costs of infrastructure and overpenalizes the population in its routine appropriation of the city (Table 3).

2/3 of its radius, by integral calculus). By 'urban sectors' we understand the tracts of Census 2000, identified with the help of satellite images. The 'urban centre' is the cross of the two axes of the metropolitan core: the Monumental Axis and the Road Axis (IBGE, 2011; Ribeiro, op cit.).

⁴Bertaud and Malpezzi, 1999.

Table 3: Density (hab/ha) in main Metropolitan Regions of Brazil

Metropolitans Regions	Density 2000 (inhab/ha)	Density 2010 (inhab/ha)
MR of São Paulo	68.02	76.64
MR of Belém	69.36	71.05
MR of Recife	67.39	70.65
MR of Salvador	81.73	67.2
MR of Rio de Janeiro	62.3	61.7
Brazil Metropolitan	49.58	45.78
MR of Natal	63.01	41.99
MR of Fortaleza	53.18	41.23
MR of Vitória	35.82	35.54
MR of Belo Horizonte	45.62	33.65
BMA	28.52	29.84
MR of Curitiba	34.63	29.64
MR of Maringá	27.85	27.46
MR of Goiânia	29.9	27.32
MR of Campinas	28.99	26.78
MR of Porto Alegre	35.98	26.03
MR of Florianópolis	16.44	19.44
Average	46.96	43.06

5. Eccentricity

For the measurements above, we have considered the CBD – Central Business District – as the crossing of the two main axes of the metropolitan core and its immediate surroundings. The distance between the CBD and the extreme point of the BMA is 114km, in the city of Cristalina, to the South.

Fragmentation, dispersion and low densities already indicate serious problems of the urban configuration of the BMA. Add one more problem to that: the *eccentricity* of the metropolitan core. The originally planned part of the Capital (Pilot Plan and its immediate surroundings) have never been “central”. This is true for the municipality of Brasília and for the metropolis as a whole.

To characterize the situation, we propose that cities present three types of “centres”:

1) the *functional* centre, the point around which is the majority of jobs and services concentrate (the CBD; the centre is represented by the point in which the two structural axes of the Pilot Plan cross);

2) the *demographic* centre, the point that minimizes average metric distance *per capita* for the inhabitants of BMA, considering the place of living – say, the “centre of mass” of the system⁵;

3) the *morphologic* centre, the topologically most accessible point of BMA: the midpoint of the most integrated line of the axial map⁶.

This results in a curious “tri-cephalous” metropolis, in which the three centres are separated by long distances: 1) the demographic centre is 11.4km away from the functional one; 2) the morphologic is 8.50km away from the functional ; 3) the demographic centre is 3.5km away from the morphologic one.

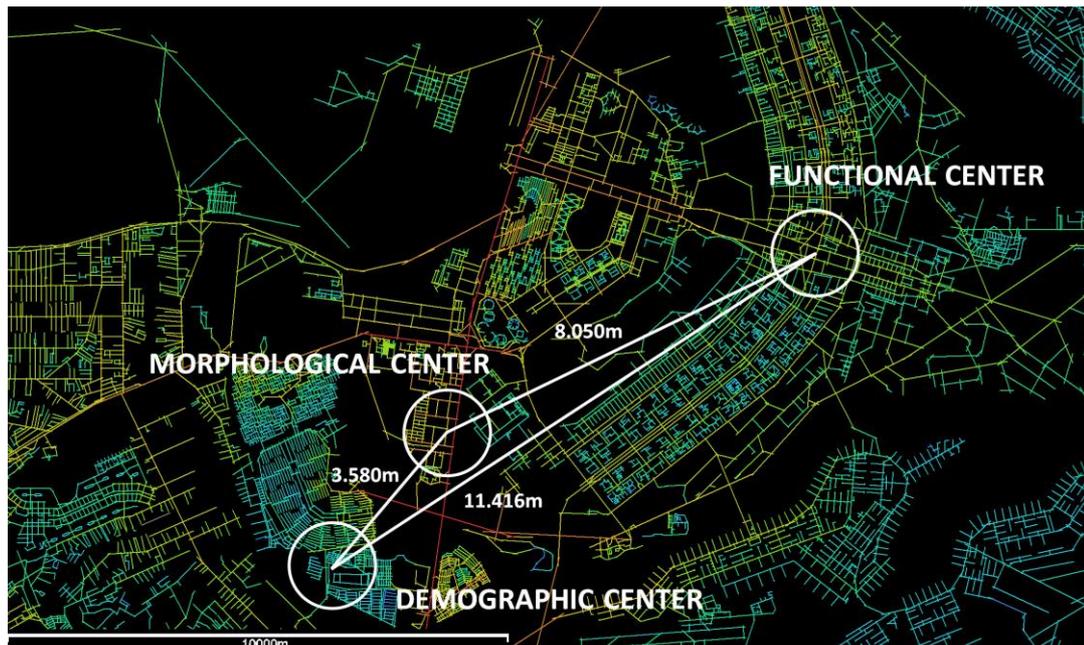


Figure 8: Localization of the demographic, the morphologic and the functional centres of the BMA

According to Miragaya (2013), based in CODEPLAN (2012), from the 1,078,260 jobs existing in Brasília, 514,500 concentrate in Administrative Region 1 – 47.72%. The second Administrative Region in number of jobs is Taguatinga, but only with 8.96% of the jobs of the city, about five times less than Administrative Region I, but with 72% more inhabitants. The recent growth of the satellite nuclei is rather demographic than economic.

Such concentration of jobs in the theAR-I is illustrated in Table 4. It shows, per AR, the number workers the jobs of whom are located in AR-I. Note also that 91.5% of the workers who live in AR-I work in this very same region, thus revealing how poor the economic dynamics of the periphery is.

Figure 9 illustrates how unbalanced is the relation between place of living and place of work (in a conventional scale, circles superimposed on the ARs represent the number of inhabitants and the number of jobs in each AR. The strong attraction of jobs by the centre is clear).

⁵The demographic centre of the BMA was detected by GIS techniques, using information from Census 2010. Such centre is the point that minimizes physical distance to all the inhabitants of the metropolis; for the calculation, we consider the centroids of the census track and its respective populations. The demographic centre – that we could also call the “centre of mass” – is in the periphery of the satellite nucleus of Guará.

⁶ The morphologic centre was detected by means of SST techniques. It is the central point of the most accessible (or most “integrated”) line of the axial map of the BMA; it is in the Industry and Supply Park Road, to the west of the residential wings of the Pilot Plan.

Table 4: Percentage of workers with job in Administrative Region I - Brasília (for Administrative Regions of FD)

<i>Administrative Regions</i>	<i>% workers of AR that work in Administrative Region I – Brasília</i>
<i>Brasília</i>	<i>91.49</i>
<i>LagoNorte</i>	<i>85.71</i>
<i>Sudoeste/Octogonal</i>	<i>82.19</i>
<i>LagoSul</i>	<i>71.32</i>
<i>JardimBotânico</i>	<i>69.91</i>
<i>Cruzeiro</i>	<i>65.89</i>
<i>Park Way</i>	<i>58.6</i>
<i>Guará</i>	<i>50.3</i>
<i>Sobradinho II</i>	<i>46.82</i>
<i>Candangolândia</i>	<i>45.51</i>
<i>ÁguasClaras</i>	<i>44.61</i>
<i>NúcleoBandeirante</i>	<i>44.07</i>
<i>Santa Maria</i>	<i>42.64</i>
<i>Sobradinho</i>	<i>41.12</i>
<i>Vicente Pires</i>	<i>38.83</i>
<i>Riacho Fundo</i>	<i>37.42</i>
<i>Planaltina</i>	<i>37.28</i>
<i>Gama</i>	<i>35.9</i>
<i>São Sebastião</i>	<i>35.12</i>
<i>Taguatinga</i>	<i>34.07</i>
<i>Paranoá</i>	<i>33.78</i>
<i>Itapoã</i>	<i>32.09</i>
<i>Varjão</i>	<i>31.62</i>
<i>Recanto das Emas</i>	<i>30.38</i>
<i>Riacho Fundo II</i>	<i>30.18</i>
<i>Ceilândia</i>	<i>29.74</i>
<i>Samambaia</i>	<i>29.66</i>
<i>S I A (*)</i>	<i>29.22</i>
<i>Brazlândia</i>	<i>28.07</i>
<i>SCIA – Estrutural(**)</i>	<i>22.29</i>

(*) Industry and Supply Complementary Sector

(**) Industry and Supply Sector

Source: PDAD-DF 2011 (CODEPLAN, 2012)

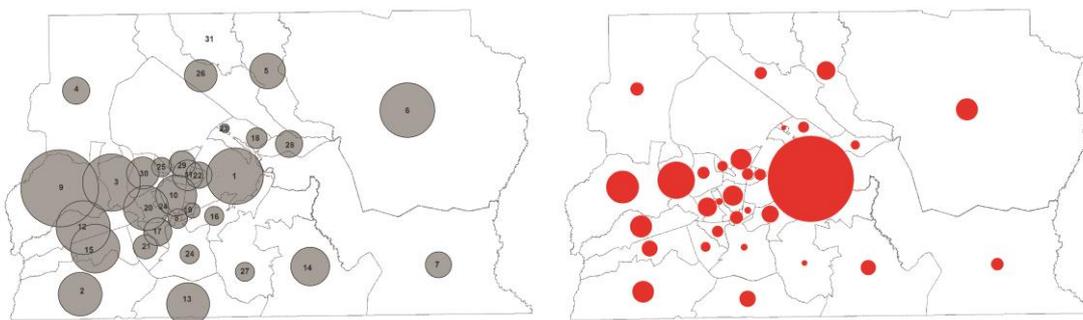


Figure 9: Graphical representation of the number of inhabitants (left) and the number of jobs (right) per Administrative Region of Brasília

As to the other cities of the BMA, except Brasília, 53.54% work in the city where they inhabit and 45.03% work in Brasília (Table 5, Figure 10). In turn, from those who work in Brasília, coming from other cities of BMA, 60.24% work in AR-I; they are followed, far behind, by Taguatinga (9.34%) and Gama (5.57%)(CODEPLAN, 2013). This confirms the strong attraction of the metropolitan core in the BMA and, inside it, of AR-I. However, percentages vary a lot. Cities may be distinguished in two groups: 1) the ones that pre-existed the Capital, outside the borders of Brasília, as Formosa, Cristalina, Alexânia, Padre Bernardo and Luziânia (they have consolidated economies and a relative autonomy); and 2) the ones that constitute the immediate conurbation around the metropolitan core, which have appeared as a result of the foundation of the new Capital: Planaltina (GO), ÁguasLindas de Goiás, CidadeOcidental, Sto. Antônio do Descoberto, Novo Gama and Valparaíso de Goiás.

Table 5:BMA: distance to CBD, percentage of employees who work in the municipal main district, and population in 2013

MUNICIPALITY	Distance to CCS (km)	% of busy people who work in the municipality in which they live (*)	POP 2013 (**)
Cristalina	131	97.09	51,183
Padre Bernardo	111	91.83	31,705
Alexânia	89	91.09	25,392
Formosa	82	89.58	108,466
Luziânia	60	80.12	189,225
Planaltina	60	30.14	87,423
ÁguasLindas de Goiás	50	37.54	197,530
CidadeOcidental	50	47.46	70,832
Santo Antônio do Descoberto	48	39.98	73,023
Novo Gama	44	40.02	102,949
Valparaíso de Goiás	42	42.05	168,961
Brasília	0	99.11	2,789,761

(*) PMAD 2013

(**) PMAD 2013, except Brasília (IBGE)

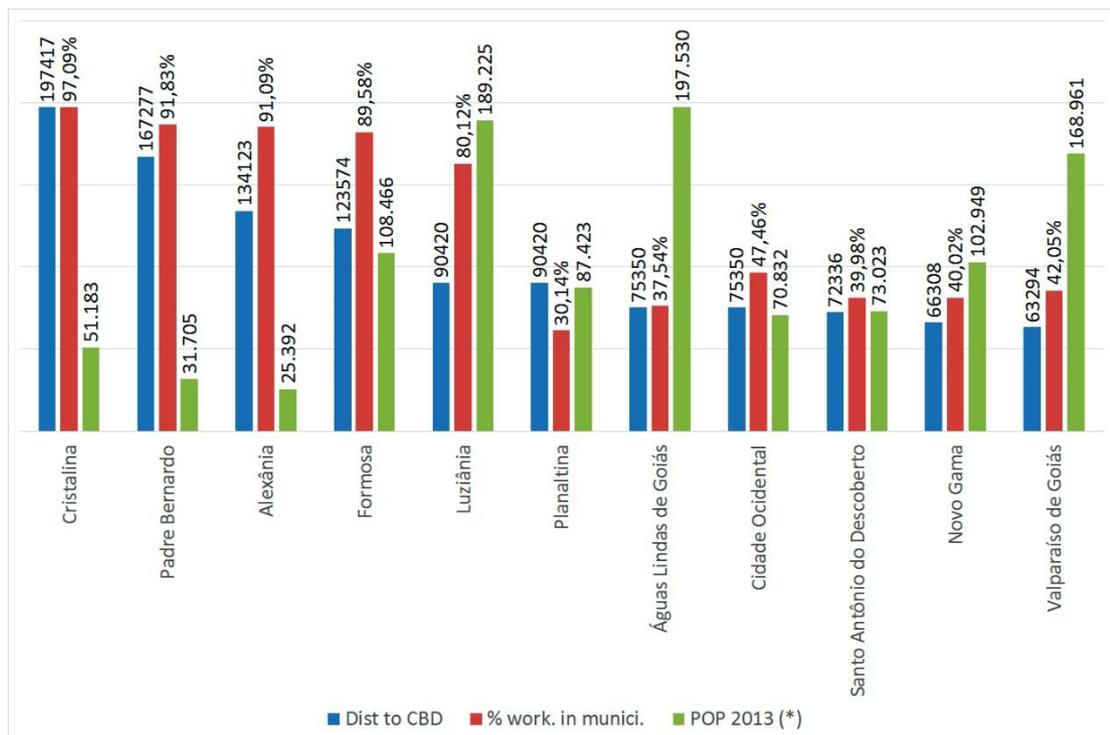


Figure 10: Cities of the BMA, except Brasília. Distance to the CBD, % of employees who work in the municipal main district, and population in 2013. (Red columns have been “normalised visually”, i.e. we have multiplied percentages values, which are numerically right in the figure, by the factor 378,227, to make the columns that represent them visible.). Source: PMAD 2012

The social costs involved in all this are high:

- distances among houses are aggravated, because the most accessible point of the city (morphologic centre) is far from the point that minimizes the distance between the inhabitants (demographic centre): the high demographic concentration to the West “pulls” the demographic centre towards that direction;
- distances among residence/work/services are aggravated, because the demographic centre is far from the functional centre, i.e. the heart of the metropolis, in which the headquarters of the federal agencies, the main cultural, educational, health and leisure facilities, the majority of the commercial and banking establishments etc. are located.

Brasília was born dispersed and eccentric. Figure 11 illustrates the occupation of the great number of urban areas far away from the functional centre, since the beginnings of the city. With time, the trend for filling in the gaps is clear, although not as fast as necessary, nor with the best morphological solutions. For example, gated communities proliferate. They densify the urban fabric but do not improve the axial structure of the system (Freitas, 2013).

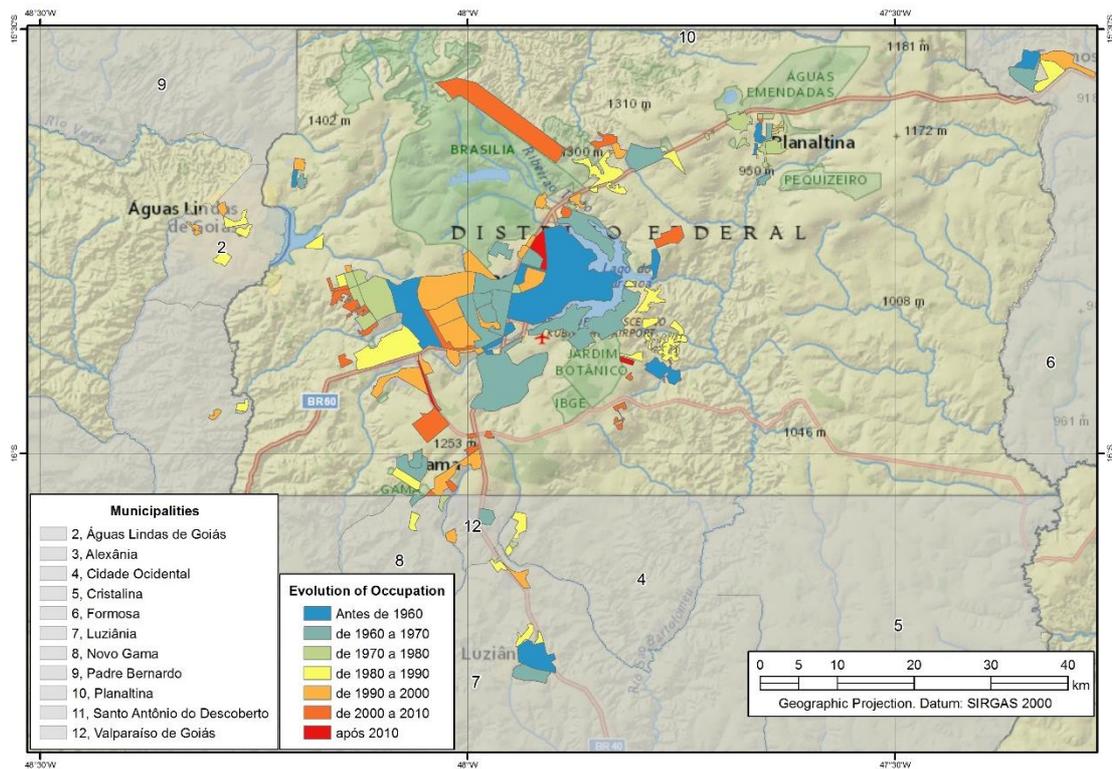


Figure 11: Evolution of urban occupation of the metropolitan core. Colder colours (tending to blue) refer to older occupations; warmer colours (tending to red) refer to more recent ones

Low densities, territorial dispersion and eccentricity impose high costs upon the population of the Federal Capital, particularly the poor – public transport fares are among the highest in the country. To these aspects, we should add the discoordination between land use and transportation policies, which impairs, for example, the performance of the subway – badly dimensioned (only four wagons, overcrowded in peak hours) and with lines which are ill-localized, in contradiction with the main routes of movement and high densities of jobs of the metropolis. This is particularly true in the Plan Pilot: the metro goes under the lawn of the Road Axis, not under the main commercial thoroughfare of the W3 Avenue, running all along the Pilot Plan from north to south, parallel to the Road Axis. Limited to the territory of the municipality of Brasília so far, it has, in one end, the dormitory nuclei with greatest demographic densities; and, in the other, the functional centre – these ends being separated by 40km. In between, we have the great voids of the dispersed city. The territorial policies do not contemplate the occupation of these voids by housing, even less so by jobs and services, that could feed the subway line across space and time.

6. Conclusion

The morphologic problems of the BMA could be faced by urban policies that would: 1) increase the number of inhabitants in its most central parts, thus reducing the metropolitan dispersion and improving relations housing *versus* work; 2) improve the distribution of jobs and services in the satellite nuclei of Brasília and in the cities beyond, and along the transit corridors, thus intensifying land use. Mobility problems are so serious that the first measures are being taken to increase the number of jobs in satellite nuclei and to bring down the intense commuting between them and AR-I. An example is the new Administrative Centre of the local government, that should have gone to the Aguas Claras borough 20 years ago and only today is being built near Taguatinga, Ceilândia and Samambaia, close to the metro line; together, the three satellite nuclei concentrated, in 2011-2012 (CODEPLAN, 2012), 803,941 inhabitants, 31.4% of Brasília's population. In addition, they had, together, in 2011, *circa* 202,130 jobs, 18.9% of Brasília's total. As planned, the new administrative

centre will have about 15,000 employees⁷, raising in 8%, by itself, the amount of jobs in the three satellite nuclei referred to, besides the indirect jobs that would be thereby generated.

To overcome the current situation, however, we need a strong paradigm shift. Recent debates in relation to the Plan for the Preservation of Brasília as a World Cultural Heritage Site have shown that, in some aspects, government proposals are more progressive than the ferocious criticism aroused within ranks of civil society against the Plan. The latter tend to stick to a parochial vision of the city, not a systemic one, by which 1) a much wider range of aspects of the city's development would be taken into account and 2) impacts of local interventions would be evaluated in the light of its repercussion in the metropolis as a whole.

A historical disjunction between land use and transportation policies continues to prevail. In the opposite direction of trends worldwide, it is taken for granted that the priority must be to the car. This mode of transportation is not taken as a *variable*, together with other modes. It is ignored that, from all the points of view, the maintenance of the current system is unsustainable. There are proposals for new subway lines dating as back as the beginnings of the 1990's. They would intensify connections among satellite nuclei, but are so far ignored, not even listed as a future possibility. Astonishingly enough, the Transportation Master Plan predicts, from its own assumptions *and proposals*, that movement in the city will be completely jammed in 2020.

There is still much vacant land to be occupied in Brasília, the municipal pole of the BMA. However, the priorities which are announced imply occupation, again, towards the fringes of the territory, *e.g.* the creation of a new "edge" city in the south border of the municipality of Brasília, for 900,000 inhabitants, 27km away from the CBD.

The distribution of inhabitants and jobs in the core city of the BMA and the measures of topological accessibility analysed in this paper allow some statistical experimentations that may be further explored, particularly in comparison with the reality of other Brazilian metropolises. For example, consider the territorial division of Brasília in administrative regions (ARs), its respective number of jobs and inhabitants, and the measure of topological accessibility of the regions⁸. The *r-Pearson* between jobs and inhabitants is only moderate, tending the low: 0,44; between population and accessibility, it is practically nihil (-0,02); and between jobs and accessibility, *r-Pearson* is positive, but very low: 0,11, thus corroborating the eccentricity of the jobs referred to before. Figure 12 visually illustrates the disparity between the three variables— jobs, inhabitants and accessibility—perAR.

Some simulations illustrate how these measures are meaningful considering hypothetical transformations in course (or, rather, desirable...) in a foreseeable future: 15,000 jobs of the new administrative centre (under implementation) and new urban areas inside AR-I limits, would imply a jump of *r-Pearson* inhabitants/jobs to 0.71, a very high correlation. Besides this, consider that 49% of the civil servants of the local government live in Taguatinga and neighbouring ARs, but only 22.70% of them have now their jobs in there; they will strongly benefit from the new administrative centre. On the other hand, the impact of the urban nucleus of 900,000 inhabitants in Brasília's south border will be extremely negative.

⁷<<http://www.seplan.df.gov.br/noticias/item/2356-gdf-detanha-formas-de-ocupa%C3%A7%C3%A3o-do-centro-administrativo.html>>. Access: may, 2nd 2014.

⁸We have sort of "translated" the line integration measures into ARs' integration measures. As we do not have digital maps for the new ARs limits, we could not use automated GIS procedures in this case. We found these measures manually: we have identified, in *Depthmap*, the integration measure of the most central line in each AR, and have used this as a conventional measure for the AR as a whole.

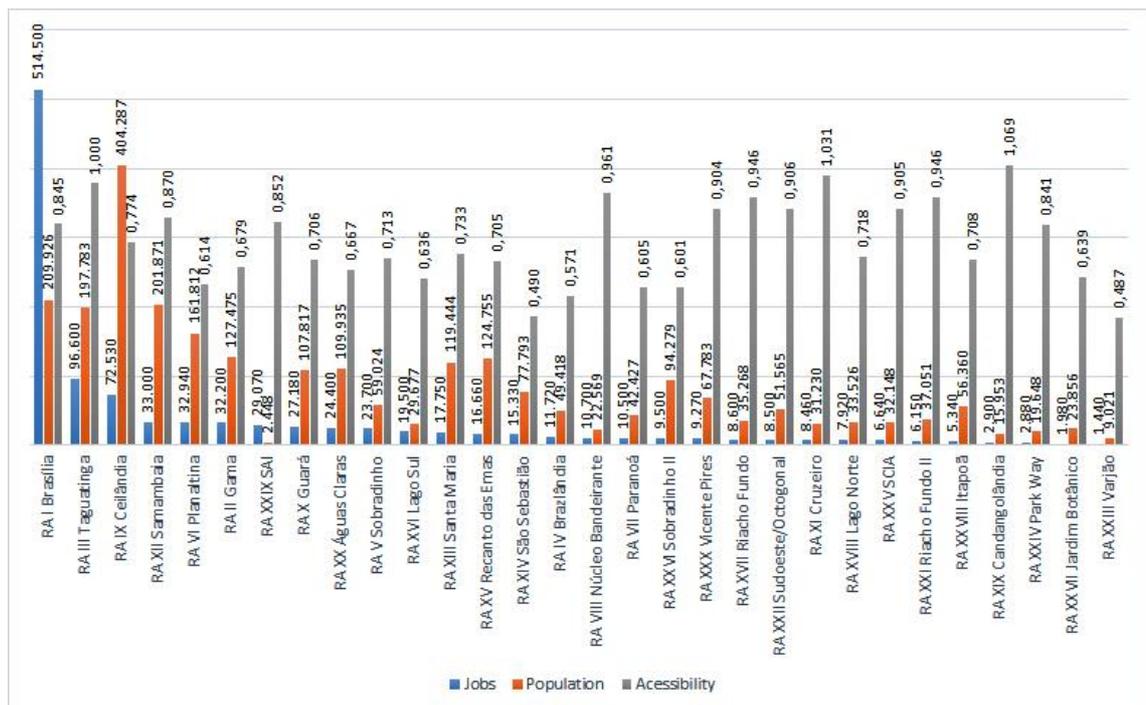


Figure 12: Jobs, population and accessibility per Administrative Region of Brasília. (Grey columns have been “normalised visually”, i.e. we have multiplied integration values, which are numerically right in the figure, by the factor 378,227, to make the columns that represent them visible.)

Finally, the update of the Territorial Organization of the Federal District Master Plan, proposed by the local government in 2012 and still with the legislative power, foresee an addition of 56,602 hectares of urban areas, 9.67% more than today’s occupied land. In foreseen densities, the addition would be of 7,731,866 inhabitants, a quite unrealistic scenario, which by far surpasses population growth estimates for the BMA for the next 20 years, when population should stabilize at much lower levels.

Independently of how much space should be occupied, it matters the way it should be occupied, establishing priorities to minimize the serious problems of territorial organization and land use patterns discussed in this paper, both for the BMA in general, and for its core city, in particular.

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