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## Session: Urban density and land use in metropolitan areas.

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### “Brasilia spatial structure: Between the Cult of Design and Markets”

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*New version: August 2010*

#### **A. Brasilia: conceived as an abstract, self sufficient, finite and perfect object**

Lucio Costa designed Brasilia at a time when most planners thought that cities would reach an optimum size, beyond which they would become unmanageable. Many thought that it was the duty of planners and government to prevent cities from growing beyond this optimum limit.

Brasilia population target, set at 500,000 inhabitants, was reached around 1970. Apparently a believer in the myth of a city's optimum size, Costa designed Brasilia without any plans for expansions. Deliberate or not, the lake surrounding the center city to the South East and the enormous national park located to the North West are inbuilt immovable obstacles that prevent any contiguous spatial expansion.

The concept of a meticulously designed city with a fixed population became later the curse of Brasilia. The decision by UNESCO to name Brasilia a World Heritage Site in 1987 contributed to further freeze Brasilia into an icon of

modernist architecture and planning. The original design concept that created Brasilia – a city designed entirely for the automobile around 2 highways crossing each others and where pedestrian and bicycle trips are nearly impossible<sup>1</sup>, contradicts all modern urban principle and has no roots in the rich traditions of Brazilian architecture and planning.

The government complete control of the land within the federal district surrounding the *Plano Piloto* provided a false assurance that it would be possible to preserve the abstract concept of a scientifically designed city of an optimum size. Illegal subdivisions appeared early in the history of Brasilia but failed to warn government planners that the finite city concept was fallacious. The hope to control population growth was also associated with a desire to control the income of migrants. Brasilia was built under the illusion that only middle class households will inhabit it. Government's planners felt that by preserving the high infrastructure and housing standards of the original design they would set an example of "good urban planning". Migration to Brasilia was to be restricted to households with a sufficient income to afford the high standards provided within the *Plano Piloto*.

The emphasis on an abstract aesthetic and design lead to a disregard for the land demand coming from new migrants whose labor was indispensable to the economic development of the city. The lack of "designed" extension for Brasilia contradicted basic urban economic principles. There is indeed a well established direct relationship between efficient labor markets, urban productivity and urban shape as demonstrated through empirical analysis for a number of cities around the world by Prud'homme (1997,1999) and Cervero (2007).

The conceptual shortcomings of Brasilia's initial design would not have had major negative consequences if right after the implementation of the "plan piloto" the supply of land would have been responsive to demand for housing by workers migrating toward the new capital. Additional land areas could have been developed next to the "plan piloto" with standards affordable to the very people who were densifying the new mushrooming illegal settlements. Or in other words, if the high demand for land around areas of high employments and amenities level had resulted in high densities. After all, all the large new cities built during the last two centuries were built around a designed core that allowed expansion and growth. For instance, that was the case for Washington, New Delhi, Canberra, and Chandigarh. Brasilia has been the only exception.

Instead of recognizing the demand for land – expressed through informal settlements – in areas adjacent to the jobs concentrated within the "plan piloto", the

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<sup>1</sup> Indeed, there is not even a public footpath or a bicycle track around the magnificent artificial lake surrounding the "plan piloto"!

government reluctantly created satellite towns far away from the existing jobs to relocate households living in illegal subdivisions closer to the city center.

After creating the nucleus of the city and its prestigious governmental function core, the government used its monopolist control of land market to contradict the self-organizing principles that guide the development of most of the major cities in the world. The trade-off made by households and firms between land and floor space consumption and distance to the city center is quasi universal. This trade off manifests itself by high densities in the city center and lower densities toward the periphery. The complete legal control over the vast areas of the federal district allowed the government to pursue its dream of a utopian city without poor and with a spatial organization reversing thousands of years of urban traditions. The cult of design based on the fallacy that a modern city could be built around the automobile resulted in a low density core physically isolated from a string of fragmented and dispersed high density non descript suburbs where the poor and the middle class are currently living.

Before discussing what could be done to improve the functioning of the current Brasilia, I will briefly describe below the spatial pattern of densities found in most metropolises around the world and how Brasilia contradicts this self-organizing principle.

### **B. The spatial structure of Brasilia compared to other metropolises**

The pioneering urban economic work on cities spatial structures conducted by Clark (1951), Alonso (1964), Mills (1967) and Muth (1967) were only being developed while Brasilia was being conceived and built. However, this theoretical work would have been unlikely to percolate from the world of academia to the operational world of architects and urban planners at the time of Brasilia's creation. The "percolation" of ideas between urban economists working mostly in academia and the operational world of urban planning is not yet complete to this day!

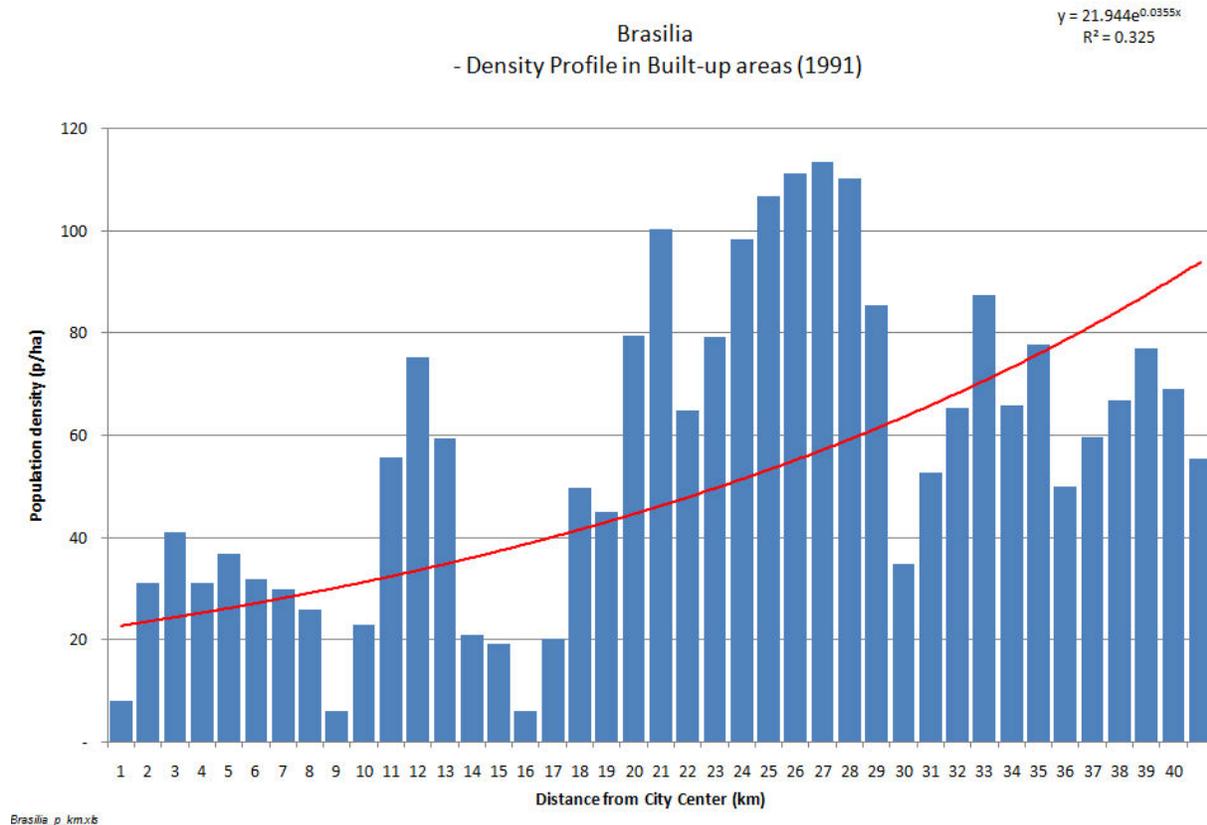
The impact of urban form on urban productivity, directly linked to labor spatial concentration and labor spatial mobility, has been formulated only recently. A new understanding of the economics of large cities based on the increasing return to scale provided by large labor markets is now able to explain a posteriori the recent emergence of megacities (Prud'homme, 1997).

Obviously, cities existed and developed successfully much before any economic theories could explain their existence. In the same way as life on earth existed much before any biologist could explain its complex mechanisms. The parallel between cities and living organism is appropriate as cities develop

following self-organizing principles very similar to organic growth. In addition, cities, like living entities are also submitted to Darwinian forces that oblige them to either evolve and adapt or decline and die. Contradicting these principles through government fiat has its price.

The transport and housing affordability problems faced by the current inhabitants of Brasilia – so well analyzed and quantified in the paper presented by de Holanda, Ribeiro, and Medeiros at ISOCARP congress in 2008 (de Holanda 2008) – came from the reluctance to allow the city to grow beyond the originally planned 500,000 inhabitants and beyond the design of the “plan piloto”. The relocation of squatters and the opening of satellite towns at more than 25 km from the original city center, where most of the job were located, made the problem worse. The profile of population densities in the built-up areas of Brasilia, measured from the city center of the Plano Piloto toward the periphery explain the structural problem faced today by the inhabitants of Brasilia and by the cities managers who have to deliver efficient transport and urban services (*Figure 1*).

The profile of density shown on *Figure 1* shows the densities increasing as one goes further away from the city center. This peculiar spatial pattern lengthens transport distance and commuting trips and the length of infrastructure networks. This pattern of densities is due to the way Brasilia was initially conceived; it would be difficult to reverse it, as we will see below.



**Figure 1: Profile of built-up densities in Brasilia as measured in 1991**

The allocation of land by government fiat has also segregated income by distance from the center. In most cities income segregation by neighborhood is common, but poor households can be encountered at every distance from the city center. Poor households can afford to live closer to the center and compete for land with higher income households by consuming less land and by having lower infrastructure standards. De Holanda (2008) describes the settlement of Vila Planalto located at only 1.5 kilometers from the Three Powers plaza. Developed originally as a camp for the construction staff building Brasilia, it had large variations in lot sizes with 47% of lots smaller than 100m<sup>2</sup> and some street narrow enough to prevent vehicular access. These low standards allowed low income households to afford housing in an excellent location. But Vila Planalto is an exception in Brasilia and an historical accident contradicting the original design concept.

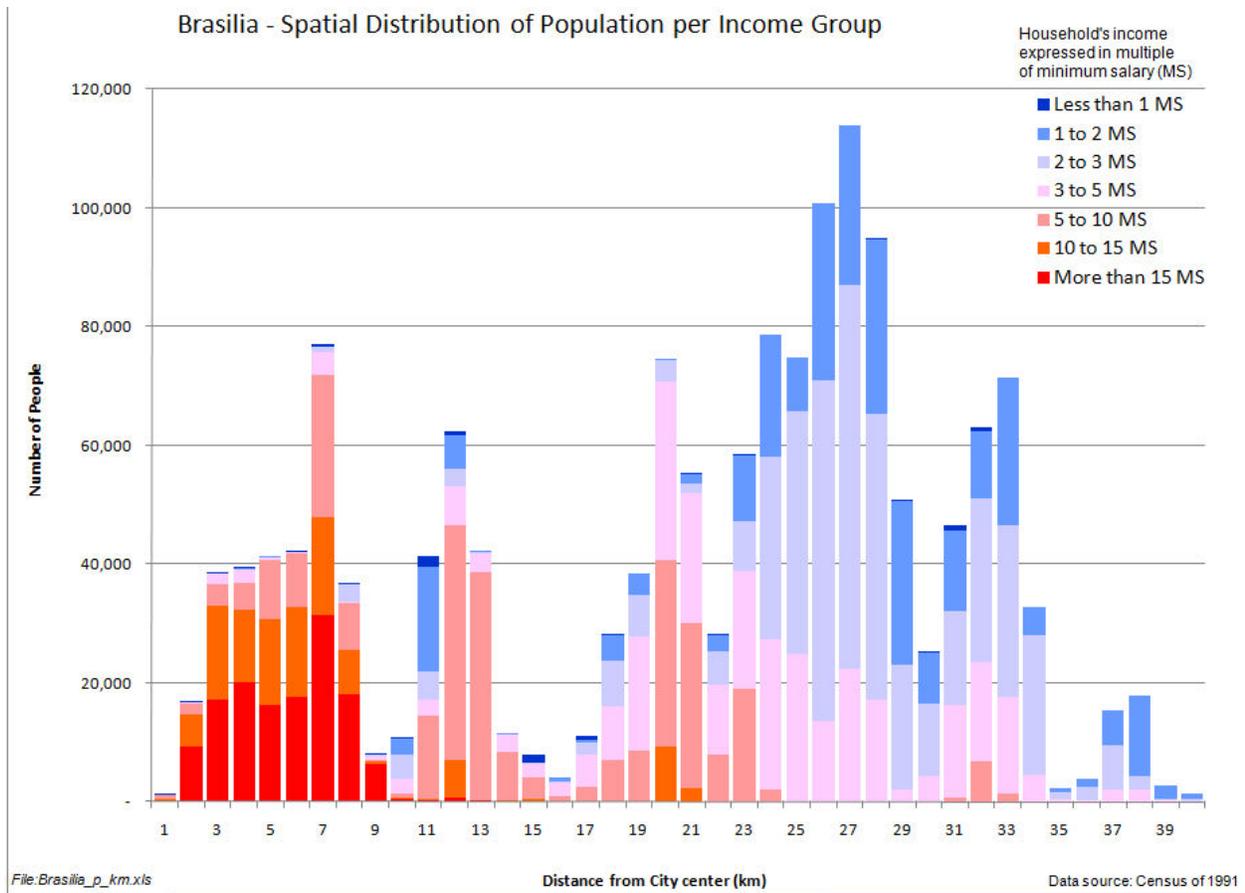


Figure 2: Brasilia: Spatial income distribution by distance from the city center

The lower income groups are now located the farthest away from the city the center. *Figure 2* illustrates this point. It shows the high concentration of poor households located at more than 20 km from the city center. *Figure 3* shows in a less abstract way the type of lower income settlements in Ceilandia located at 32 km from the city center and shown as blue bars in the graph of *Figure 2*.



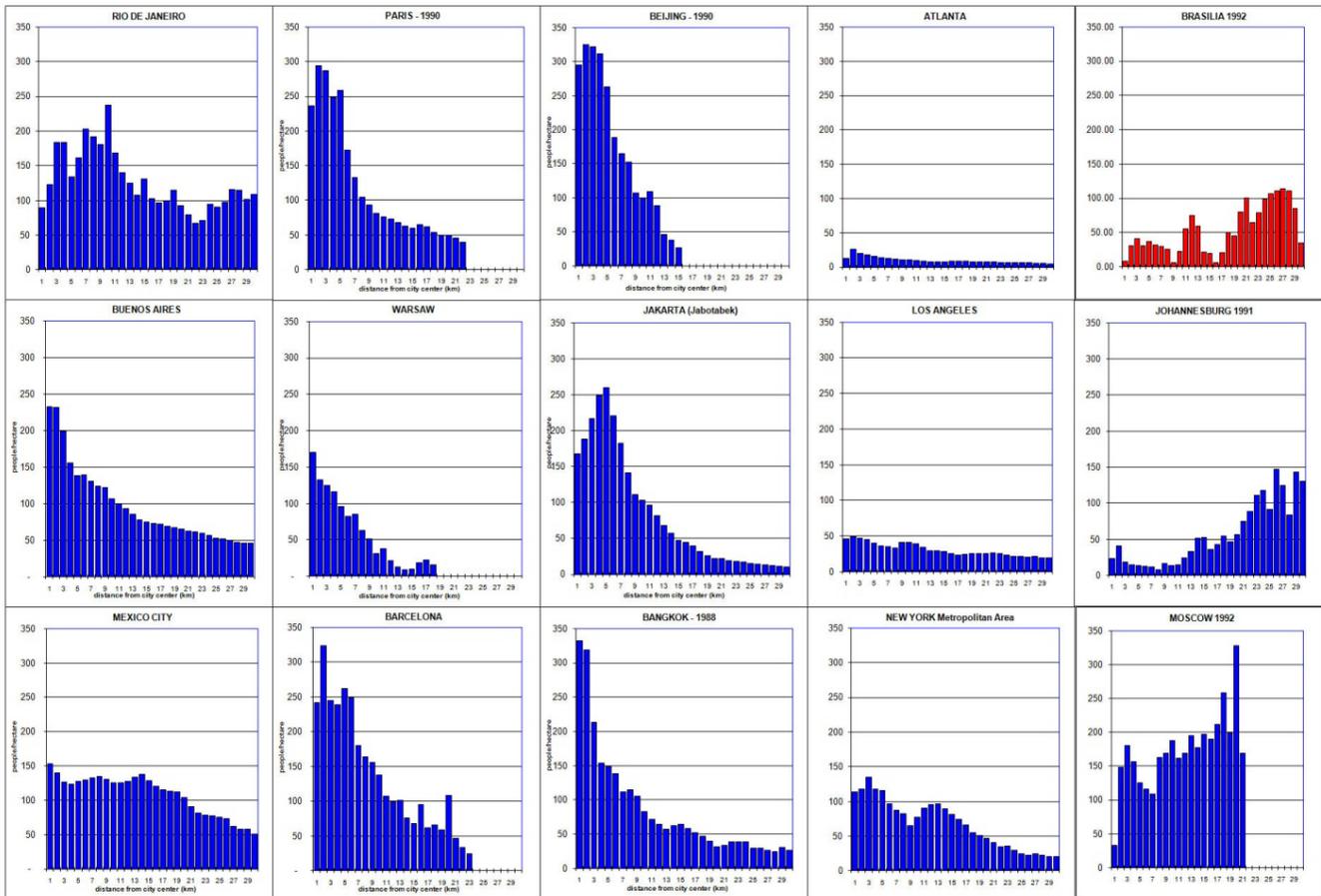
Figure 3: Low income settlements in Ceilandia

### *The self organizing spatial structure of large cities*

The population density of the large majority of cities around the world follows a simple pattern: densities decrease progressively from the center to the periphery (*Figure 4*). This regular pattern is found across culture, climate, and income. This profile is found in strongly monocentric cities as well as in polycentric cities. This convergence in urban spatial structure across continent is not created by urban planners' design but through the self-organizing forces created by supply and demand for land and floor space. In some cities, infrastructure and topography may disturb the symmetry of density gradients but the decrease of densities with distance is encountered everywhere. The urban economists mentioned above have formulated the theory explaining this regularity.

This pattern of densities has a big advantage for households as well as for the operation of cities services. It shortens distance to jobs (even in a polycentric city) and it reduces in general the length of networks.

## COMPARATIVE POPULATION DENSITIES IN THE BUILT-UP AREAS OF SELECTED METROPOLITAN AREAS (1990)



from "Order Without Design", Alain Bertaud, 2002

Figure 4: distribution of built up densities in 15 cities

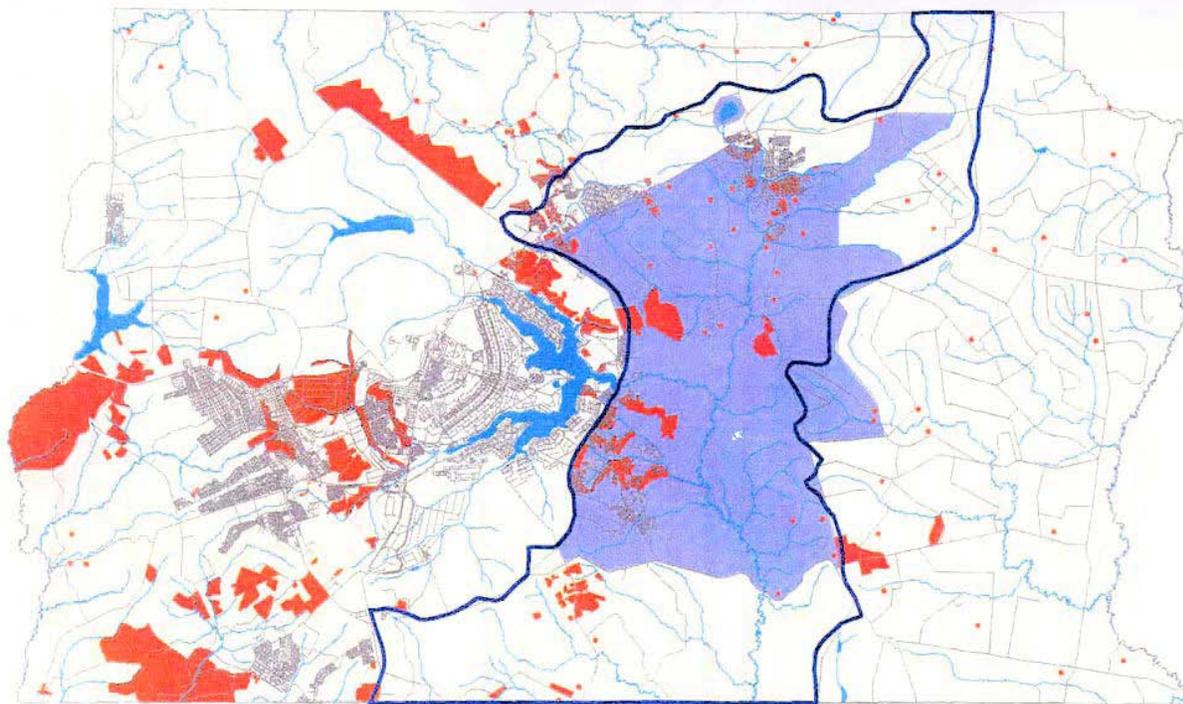
However, there are a few exceptions: Brasilia, Johannesburg (1992) and Moscow (1991) whose density profile is shown in rightmost column of *Figure 4*. These three cities with a reverse density profile have not much in common, except that in each of them during a long period of their history the land market was not allowed to function and government planners' decisions were substituted to markets in allocating land to households and firms. The limited scope of this paper does not allow developing much further the reasons why densities decrease with distance when markets are allowed to play their role<sup>2</sup>. However, the density profiles of Moscow and Johannesburg, measured 10 years later (2002) – after land markets have been partially restored – are showing a return toward normality where densities are increasing toward the center and decreasing toward the

<sup>2</sup> Bertaud, Alain and Bertrand Renaud. "Socialist Cities Without land markets". *Journal of urban Economics*, 41, 1997, pp137-51

periphery. While I do not have an update of the density profile of Brasilia, which on *figure 4* is based on the 1991 census, I doubt that there would be much change in the profile. I would even guess that the density of population in the periphery is even higher now in 2010 than what it was in 1991.

### C. The artificial constraint imposed on the supply of developed land is the main issue to be solved for the future development of Brasilia

The main problem that faced Brasilia since its creation has been a scarcity of developable land. The large areas of land developed illegally acted as a safety valve for households unable to find housing in the formal market (*Figure 5*). The households unable to find housing in the formal markets were not limited to low income but included also middle class households.



Source: F. de Holanda, R. Ribeiro, V. Medeiros, *Brasilia: costs of dispersion*, 44th ISOCARP Congress 2008

Legenda

- Limites da Bacia do Rio São Bartolomeu
- Limites da Área de Proteção Ambiental - APA do Rio São Bartolomeu
- Parcelamentos irregulares

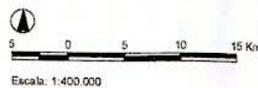


Figura 02

APA / Bacia do Rio São Bartolomeu e Parcelamentos Irregulares no Distrito Federal

Figure 5: Map of illegal subdivision within the Federal District

The population of Brasilia is going to continue to increase in the future. The capital of the fifth largest country in the world and of one of its most dynamic economy is bound to attract more economic activities in addition to the ones inevitably linked to the development of the federal government administration. It is

time to have a plan that will accommodate this future growth and that will progressively correct the spatial shortcomings of the existing city.

To resolve the spatial issues described above we need to answer the following questions:

- 1) What should be the future structure of the city: dominantly monocentric or polycentric?
- 2) Where new land should be developed or redeveloped?
- 3) What type of infrastructure should be built to support this new spatial structure?
- 4) What land use regulations would be consistent with the new spatial structure?

### Monocentric or polycentric?

With 3.5 million people in the metropolitan area, Brasilia is not a blank slate anymore. Consequently, the reality on the ground severely limits the choices between alternative future spatial structures. Currently, while the population is widely dispersed over a wide area, most formal employment is still concentrated within the Plano Piloto area. Would a dispersion of employment to match the current dispersion of population reduce transport costs and increase urban efficiency?

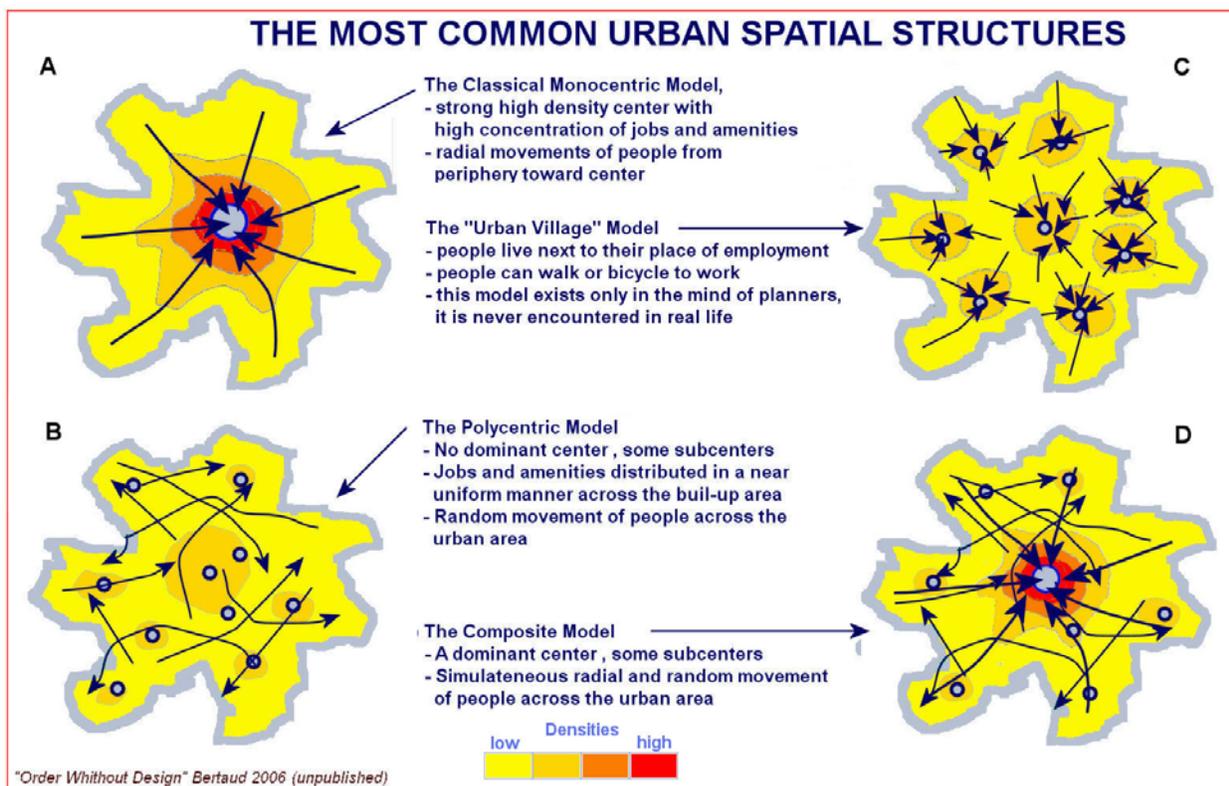
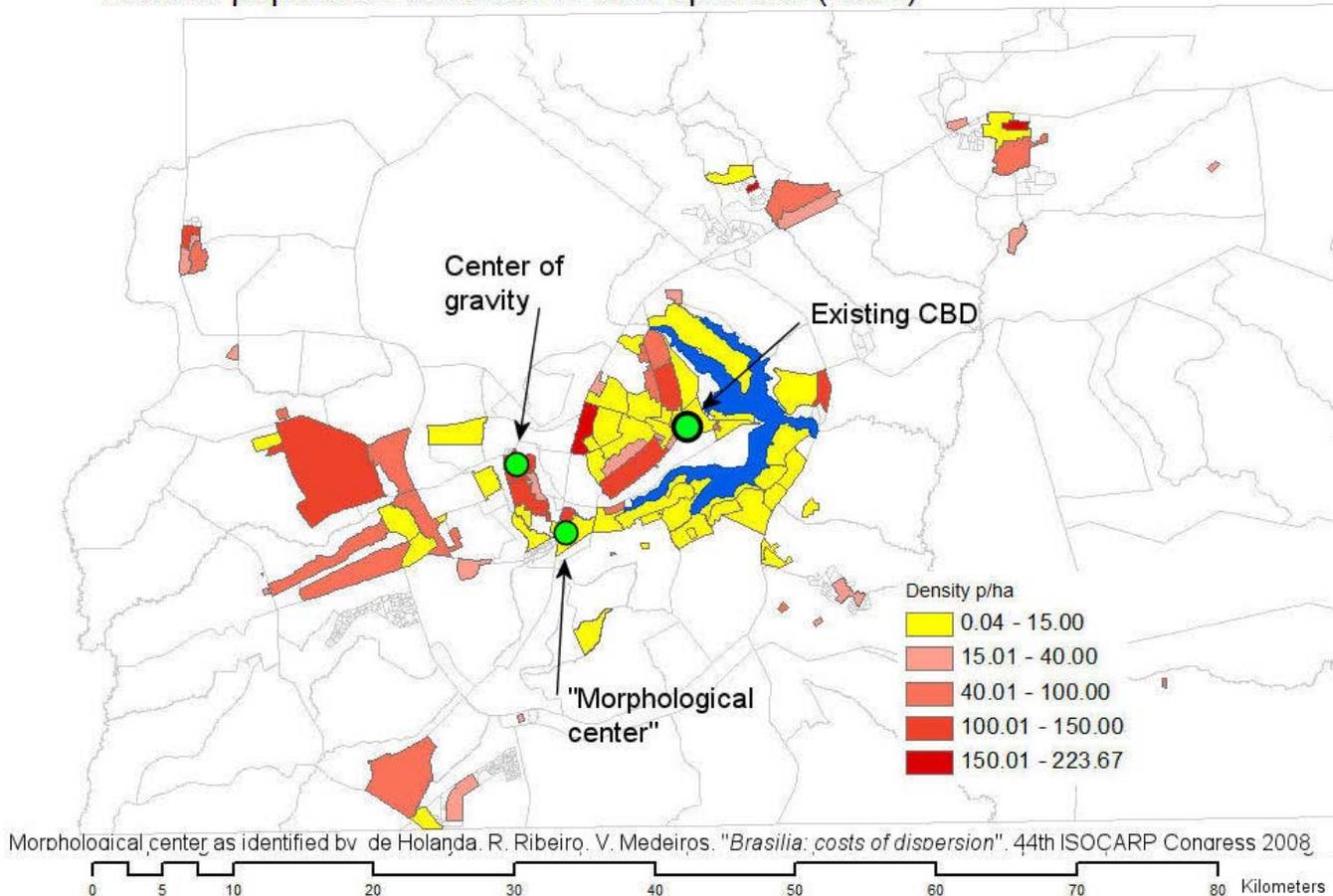


Figure 6: Alternative urban structures

To answer this question let us look at a more general model of alternative urban spatial structures. The schematic representation shown on *Figure 6* summarizes the most common urban spatial structures. When it comes to employment concentration, the monocentric model (upper left corner *Figure 6*) is the schematic model that is the closest to the reality on the ground of Brasilia with about 80% of formal jobs in the Plano Piloto CBD. However, as we have seen, the current pattern of residential densities would be closer to the “urban village model” (upper right corner). Unfortunately, the pattern of trips represented on this model does not really exist in the real world. This pattern exists only in master plans. Labor markets in large cities tend to integration. The fragmentation of labor markets implied by the “urban village” model would contradict the economic *raison d’être* of large cities that are the increasing return to scale procured by large integrated labor markets as demonstrated by the work of Prud’homme and Cervero. Because of the reality on the ground, it seems that a variant of the monocentric model will have to be invented for Brasilia.

#### Brasilia population densities in built-up areas (1991)



The current CBD in the Plano Piloto is not particularly well located and

would have difficulties to expand. As pointed out by de Holanda (2008) the current CBD does not correspond anymore to the demographic center of gravity of Brasilia. This new center of demographic gravity is located about 12 km to the west of the current CBD (*Figure 7*). Calculating what de Holanda call the “morphological center” , i.e. the point the most accessible by the metropolitan population through the existing road network, point to another alternative center at about 10 km South West from the current CBD. In most dominantly monocentric cities, the CBD, the center of gravity and the morphological center roughly coincide.

We could conceive then of a new schematic spatial structure for Brasilia, that would reflect the reality on the ground while allowing in the long run to lower transport time and costs, to provide for the expansion of new economic activities, and to preserve transit as a dominant mode of transport. This would require the development of an additional CBD more accessible to the current population.

Somewhere around the current morphological center a new CBD could be developed to accommodate the growth of new commercial and business activities together with new cultural amenities that would be needed as the population of Brasilia further increases. Brasilia would have then 2 CBD, in the same way as New York with Mid Town and Down Town/Wall Street (which are located at about 6km from each other).

There are many precedents of cities developing a new CBD to protect their city historical core. The new CBD of Beijing has been recently developed at 6.5 km East from the traditional city center, precisely to protect the Imperial Palace compound and to allow a higher concentration of business in towers not visible from the historical center. Paris, with the development of La Defense new CBD at 10 km west of the historical center, developed for the same reasons. Jakarta “Golden Triangle” new CBD was developed also 10 km to the south of the traditional CBD centered on the port area. In each of these cases the historical CBD retain a number of more specialized economic activities, while the new CBD allow the expansion of newer ones, like high tech services and corporate headquarters.

Why not select the polycentric model or the composite model instead of creating a bi-centric city?

The polycentric model can function only with private cars as the main mean of transportation (the structure of Los Angeles and Atlanta are representative of this model). In the polycentric model, the dispersion of employment makes it impossible to operate public transport. The polycentric model doesn't work well for low income households who cannot afford individual car transport. The

polycentric model requires large investments in road infrastructure to allow the random trips across the metropolitan areas that characterize it. The current structure of Brasilia seems incompatible with a dominantly polycentric model. Once a dominant CBD like the current Brasilia CBD is established, it is neither likely nor desirable to make it disappear.

The composite model would also be compatible with the current structure of Brasilia but it would imply that the trips between the sub-centers in the periphery would be done by private cars or mini-buses. Because in Brasilia the rich are close to the center and the poor in the faraway periphery, the composite model would imply that a large number of poor households would have to use a private car to get to the jobs located in the periphery, while the rich would be able to use public transport more easily. This is unlikely to happen and would require building a large new road infrastructure to link very distant suburbs together.

An alternative way to implement the composite model would be to allow the “recycling” of the vast areas of land which are largely unused within the plan piloto or that are used by parking lots (*Figure 8*). These areas could be redeveloped at high density and being adjacent to the CBD would provide easy access to existing jobs and amenities by short public transport or walking trips. The densification of the plan piloto would contribute to rebalance the center of gravity of the city closer to the existing CBD.

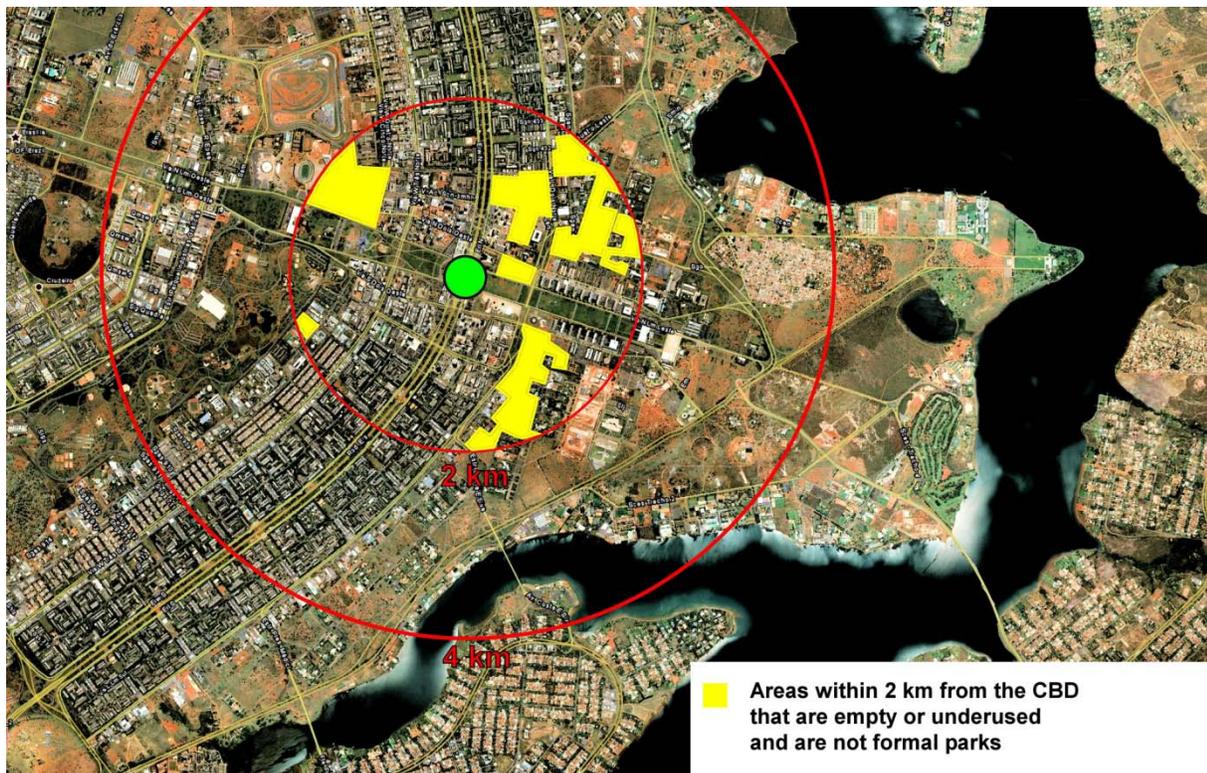


Figure 8: Underused land within 2 km from the current CBD of Brasilia

The two centers model suggested above do not imply that there would be no job creation in peripheral areas. All existing peripheral areas, mostly dormitory towns, would require the creation of sub-centers with commerce and amenities. However, the jobs in these sub-centers would be for providing local services local and are unlikely to attract much traffic from other areas.

### *The opening up a new land*

The spatial strategy suggested above would require the development of large areas of land around the new CBD and close to the existing one. The development of land around the Plano Piloto nucleus is severely constrained to the North because of the National Park and to the East because of the lake. It seems that the only alternative to stop a further fragmentation of urbanization would be to develop land to the south along route 40 and to the West along route 60. The objective would be to fill the empty space between Ceilandia and the Plano Piloto, possibly redeveloping areas at higher densities. The justification of the higher densities would be the proximity of the new CBD located at the current morphological center. The priority should be to develop as much land as possible as close as possible to the “morphological center” .

It is difficult to conceive further urban development within the federal district without the development of an active land market. It is indeed the price of land that is the major incentive for densification and for the full development of even residual land.



Figure 9: Car parking taking over the Plano Piloto

Valuing land at its proper value and using it accordingly is the basis of efficient urbanization. This principle should be extended to car parking. It seems that cars in Brasilia have a privileged situation and occupy freely or nearly freely more space than people do. The space occupied by cars in the very heart of Brasilia – where land, if it was traded, would have the highest value – shows the waste resulting by ignoring land values when allocating land (*Figure 9*). Cars have invaded the Plano Piloto area. Because land is not priced in the Federal District, it is not possible to substitute capital for land when building parking lots. *Figure 9* illustrates this point. If the land occupied by parking was priced at market, as it should be in a CBD, the existing parking at grade level would soon disappear and would be replaced by several levels of underground parking. The slab above the parking could be used for parks or office buildings. The user of car parking would pay for parking their car a price which would reflect the price of land and the construction of underground parking structure. At present the users of car parking at grade in the center and around the ministry buildings receive a subsidy (even if some pay a parking fee) which is largely paid by the workers of Brasilia who are using public transport (even if the transport they take is also subsidized, the 16 m<sup>2</sup> of downtown land in Brasilia – required for a self parked car – would be likely to be more expensive than the cost of a bus).

### *The development of an infrastructure consistent with the future spatial structure*

The development of land within the Federal District should be supported by infrastructure with sufficient capacity to allow higher density wherever there is demand for it. The new demand for land should be accommodated by creating a land market within the federal district rather than relying on the existing land market of the State of Goias where much of the growth seems to take place at this moment.

The low capacity of infrastructure should never be an excuse for reducing densities where there is demand for it. It is much cheaper to double the capacity of an existing water or sewer main than to develop new land in far away areas. Improvements in traffic management, eventually introduction of congestion tolls and better road design and the banning of on street parking would be sufficient to greatly improve the vehicular capacity of the existing road network.

Transport, and in particular transit, should form the spine of the new development. The highway network should be able to accommodate new BRT network that should complement the existing rail and metro transport system. High densities, in particular the concentration of jobs in the two business centers should make transit more attractive in the future. The transit network should be radial and

centered on the two CBDs.

Because of the dispersed low density that characterizes Brasilia, cars will always be an important part of the transport system. Urban structures are path dependent; even with a planned change of structure as advocated above, change will be slow, and cars will stay in the near future the dominant transport mode. Parking fees should be priced at market rate, reflecting the price of land. If this was done, it would encourage the construction of multilevel parking, allocating land better between competing uses and providing more space for other forms of transport and other uses.

### [The need for land use regulations consistent with spatial structure and infrastructure](#)

Land use regulations will have to be consistent with the general land use strategy of the redeveloped Federal District. Whenever there is demand for it, there is no reason to restrict densities, except for aesthetic reasons to protect views and perspective or for well-defined environmental reasons. Whether there is an open land market or not, every class of land user compete with each other. Users who are ready to substitute capital for land by building lots with high floor area ratio should be permitted to do so, particularly high income groups and businesses who can easily afford the higher operation and maintenance cost of high rise buildings . The less land high income groups consume, the more land is available and affordable for low income groups who are unable to substitute capital for land by living in high rise apartments! Regulations, therefore, should not restrict the height of residential building where demand exists unless for very specific aesthetic or environmental reasons.

Standards should be realistic about the prospective income of the new migrants to Brasilia. Low land consumption is the only way for low income households to compete for land with higher income groups. Residential standards similar to the smaller lots and streets width of Vila Planalto as described by de Holanda (2008) should be allowed or even mandated in some areas of the city.

## **D. Conclusions**

Brasilia is an economically successful city. It is the capital of one the fastest growing and potentially largest economy in the world. It is clear that in the future it will attract many more migrants; from poor farmers looking for a better life to international professionals and consulting firms wanting to locate near the decision making center of one of the largest world economy. It is therefore important to accommodate this growth by allowing land to develop in a concentric manner

around the new center of gravity of the city.

Brasilia could develop in a more equitable way if land values were recognized within the Federal District. A new CBD to the West of the Plano Piloto close to the demographic center of gravity of the city should allow in the future accommodating the new population or part of the existing population wanting to relocate closer to jobs.

Densities are difficult to establish without valuing land based on demand for it. Infrastructure and regulations should be designed to accommodate this demand for land, whether this demand comes from poor recent migrants to the city or from affluent professionals.

The modernist architecture of the Plano Piloto, of course, should remain unaffected by the new developments. The Plano Piloto could remain the well-preserved historical seed of the city of Brasilia, even if some of the residual land within the Plano Piloto are redeveloped at high densities as was suggested above. However, the Plano Piloto should not anymore constitute the only city core and the only CBD surrounded by distant dormitory towns. Recognizing the value of land would be the first step toward its more equitable distribution among the inhabitants of Brasilia. The land within the Federal District should not be considered as a buffer zone designed to keep the Plano Piloto in splendid isolation, but as an opportunity to expand the city in more compact manner with the same quality of design that presided at its foundation.

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