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Investigation Article

Bogotá and the urban location model

Bogotá y el modelo de localización urbana

JEL: R32, R38 R52 D71

Abstract. This document will present an analysis of Bogotá's urban territorial planning. It starts with a description of the neoclassical urban model in contrast with the historical evidence of the city and shows the transition process from a monocentric to a polycentric city model as a result of changes in the concentration of economic activity. This process emerges due to the saturation of the activities generated in the central nucleus - central place theory (Christaller, W. 1933)- and the appearance of centers located far away from this nucleus, with a lower hierarchy. This means that they are still linked to the principal nucleus and form part of the city's urban planning. Finally, the centers are presented through methodologies of employment concentration and land prices reflecting the dynamics of the city's territorial planning.

Keywords → Von Thünen model, neoclassical system, urban configuration, city.

Resumen. En este documento se realiza un análisis de ordenamiento urbano territorial de la ciudad de Bogotá. Inicialmente se hace una descripción del modelo de ordenamiento urbano neoclásico contrastándolo con la evidencia histórica de la ciudad. A su vez se muestra el proceso de transición de un modelo ciudad monocéntrica a un modelo de ciudad policéntrica, derivado de las dinámicas de concentración de la actividad económica. Dicho proceso se genera a través de la saturación de actividades que se produjeron a partir del núcleo central de actividades - teorema del lugar central¹- y la aparición de centros alejados de este núcleo, los cuales presentan una menor jerarquía; esto significa que no hay una desvinculación con el núcleo principal y enmarca el ordenamiento urbano de la ciudad. Finalmente se presentan los centros de actividad mediante metodologías de concentración de empleo y precios del suelo, lo cual refleja la dinámica de ordenamiento territorial de la ciudad de Bogotá.

Palabras clave → modelo de Von Thünen, ordenamiento neoclásico, configuración urbana, ciudad.

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Introduction

This article refers to the urban neoclassical location and shows the city of Bogotá as a model. It starts with a brief description of the location model described by Von Thünen (2009) and extended by Alonso (1960) which states that: the way in which agents are distributed within urban space derives from the set of individual provisions in which the objective is to maximize their profit function and develop in favour of three variables : i) distance from the business center, ii) size and iii) rent. An analysis of this model is then carried out throughout Bogotá's history by studying how the pressure of ground income has transformed the city from a monocentric to a polycentric one in which the dynamics of land prices does not depend mainly on the distance from the business center but also on the closeness to the city centers. These centers are geographically referenced through the methodology carried out by Araque and Vizcaíno (2008), which shows a new collective reference of corporate location and attraction of the demand in the city and is one of the three great structures in which the city is supported.

The neoclassical location model

Before carrying out any kind of analysis of the city, the fundamental question to be taken into account to develop studies of this type is : How is the spatial urban order constructed? With this statement in mind, and considering that the organization of the intra urban structure is not random, it means that there are certain regularities that could be identified by the discourses of social science. Abramo (2001) also refers to representations of human be-

haviour and the disciplinary peculiarities of social sciences to know how spatial urban order is constructed. In this sense, it is necessary to analyze the theoretical evolution that conforms urban space order. In this sense, it is necessary to analyze the theoretical evolution on the intra-urban order model.

The history of economic thought considered space as an important factor in people's decisions. Classical authors such as Cantillon, Smith and Ricardo had already considered the importance of manual labour and its relation to space, its consequences on productive issues and the reciprocity between the country and the city. (Abramo, 2001)

Ricardo in his analysis of land's rent, particularly in the study about the laws of grains, arguments that differential rent emerges when portions of land with decreasing or differential fertility are cultivated "or when there is a differential location"- (Valbuena, 2010).

Other authors such as Wilhem Roscher and Albert Schaffle would later develop the ideas of agricultural location under a more urban and industrial perception, influencing ideas as Von Thünen's about the optimal location of agricultural crops applied to location decisions of growing and developing industries (Muñoz Juncal, 2001).

Alonso (1960) describes Von Thünen's methodological design as a model based on monocentric urban city arrangement. The author bases his findings on the relation of price-distance from the center and establishes that there are different locations that imply different rent offers for landowners.

In this sense it can be determined that the income offered is a function of the distance to the center and of urban offers of public goods when it comes to population. This is config-

ured based on the differential sales and production costs. For this purpose, the benefits of a particular location are defined in Equation 1:

Equation 1

$$\pi_i(r, ou) = \varphi_i(r, ou) - R_i(r)$$

If the operational institutional framework of markets is competitive in the development of activities, benefits for producers are established in terms of the tensions between promoters and owners of the land $R_i(r)$, in such a way that the concurrent forces to transfer any excess above the sum of use costs of the factors to the owner of the land. As a consequence, the rent of the equilibrium implies that:

Equation 2

$$R^* = \max \left\{ \max \varphi_i(r, ou), 0 \right\} \\ = \max = \left\{ (p_i q_i - c_i), 0 \right\}$$

In this way, the stable income is the envelope of all income functions of each use or the one providing every real estate product offered. This is shown in the figure 1.

The "P" value is in the ordinate axis and "D", distance from the center, is in the abscissa angle. It can be seen that at a given place of the city some built spaces with different ground income can be offered. It also shows that in the lands below the gradients previously mentioned, at least one activity can be developed.

If two technologically associated activities are developed they would offer the same property income (Fujita & Thisse, 2002). The activity offering the highest income would get the location as shown in Equation 2. This is the principle that should govern the location of all homes and companies: the location is granted to that which is offering the highest property income.

Now, in Graph 1, $\phi_1(r,ou)$ is the economic activity that offers the highest property income so it is located close to the center as there is a possible high employment concentration. On the other hand, tends to have less mass employment, as it is farther away from the center. Thus, it is supposed that high prices of land generated by its demand, require the maximum advantage of its capacity. Mass employment de-

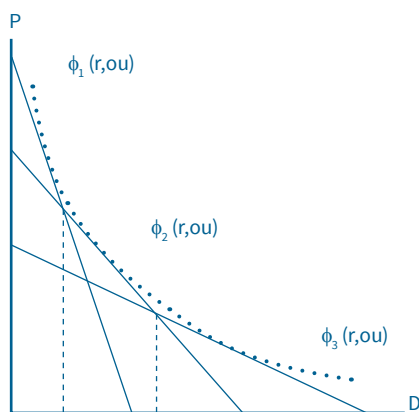


Figure 1. SEQ Graph* ARABIC Model 1 of Von Thünen. Source: Self Prepared.

scends on the axis described by the envelope given in equation 2 and the pointed curve in figure 1 is the envelope of the diverse income. (Alonso, 1960).

Alonso (1960) approaches this model of Von Thünen within a framework of individual choices to arrive to a broader Thünenian order of land use. The first advancement developed by Alonso was to define the starting point of the problem about designated space of agents in the relational election as follows:

The “geographical” distribution of agents within the space would be the added result of a set of strictly individual decisions whose unique goal would be to maximize income. Therefore, the starting point of a space theory trying to define the logic of space designation according to the principles of a rational

maximizing agent (homo economicus) would be to define a theory of the individual’s space designation. (Abramo, 2001,p11)

This economic reflection is the structure for decentralized decisions related to space by market agents. This defines the “theory” of housing choices and becomes the neoclassical synthesis of territorial ordinance is the starting point of choices in terms of location to be developed in the econometric model of this work.

The method to be developed considers the maximization of a consumer’s income whose residential location would be described in terms of the degree of satisfaction that goods can provide. (Abramo, 2001). The optimal set would be composed of two types of goods: the first one has to do with goods and services that conform the space dimension and that are divided in two : the land surface occupied by the family (q) and the distance of the residence from the city center (t). The other types of goods that do not belong to that residential dimension such as these, are grouped into a single good qualified as “composite” represented by (z). In this case the income function will be described by the following equation:

Equation 3

$$U = U(z, q, t)$$

In order to establish the indifference curves, we can suppose that one of the three factors remains constant. Therefore, the indifference curve shows the combinations between space consumption and the composite good (Graph 2) the consumption of the composite good and the distance from the business center, and consumption of space and distance. Rational individuals will always prefer to consume more space and more composed goods. On the

other hand, distance results in less satisfaction when its consumption augments as Abramo (2001):

“If the individual is rational given that employment and composed goods are available in the CBD (business center) he/she will always prefer to live as close as possible to the city center. In other words, since the individual is privileged to have the comfortable access to those goods his/her satisfaction will be more important the closer he/she is to the center. That is to say that the increase in the distance between the place where the individual lives and the city center will produce a negative income or dissatisfaction”. (Abramo, 2001, p15).

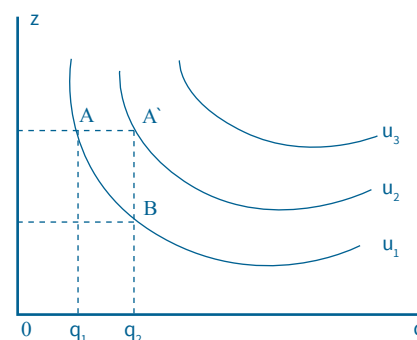


Figure 2. Indifference curves. Source: Abramo, 2001, p14.

Given the conditions stated by Fujita(2002) regarding the income function, $U(z, q)$ with the transportation cost, the following hypotheses are proposed :

Hypothesis 1 - the income function is continuous and increasing for $z > 0$ and $q > 0$; Therefore, all indifference curves are strictly convex and continuous and do not cut the axis.

Hypothesis 2 - the transport cost is continuous and increasing for $k(t) > 0$, where $0 < k(t) < y$ where y is family income.

The individual will be able to classify or organize the indifference curves of the residential location from the satisfaction criteria that

they represent. This order of preference among the sets of each curve establishes what macroeconomic literature calls “pre-order”. This concept and the understanding of the substitution marginal rate between z and q as the relation between their marginal income lead to the inclusion of budget restriction in the consumer’s maximization process in order to demonstrate the interaction between expenses in composed goods, space consumption and transport costs according to the residence location.

In this context and given that the individual does not save money, his/her income will be represented in the following way:

Equation 4

$$Y = pz + k(t) + Rq$$

Where pz is the price of composite goods z , $k(t)$ the transport cost and R the income by unit q space. At the individual level we can say that the income offer is the maximum value that an individual is able to pay to consume a designated space in a given location. This level of importance can be expressed in the following way:

Equation 5

$$R(t, u) = \max \{ Y - k(t) - z/q \mid U(z, q) = u \}$$

In this way, in the case of an individual consuming a set and located at distance t from the city center (z, q); $y - k(t) - z$, will be the amount of money that the individual has to pay for rent. When dividing $y - k(t) - z$ by q , the rent per surface unit in t is obtained.

If we solve the problem of maximizing the supply of income at a location t , subject to an income restriction $u(z, q) = u$, we obtain an indifference curve u , whose tangent represents the budget restriction.

Taking into account the individual’s budget ($pzz + Rq = yk(t)$) and supposing that pz is cash, the straight line would therefore be:

Equation 6

$$Z = Y - k(t) - Rq$$

From figure 3, it is evidenced that at higher incomes, land ownership changes the slope of the budget line. If, for example, the rent increases and the quantities z y q remain the same, a continuous straight line is obtained until z is intercepted in point A, but with a greater slope. In this case, the individual wishing to maintain his level of satisfaction will not be able to pay the rent charged, since the new budget line will be located below the indifference curve.

As a consequence, in order for individuals to have the same level of satisfaction in relation to z and q , when the land rent changes commuting expenses need to change as well. (Abramo, 2001,p27). In this sense, changing the distance and remaining in the same indifference curve enables us to see how rent offer varies with distance. If any indifference curve is used where the income level is equal to u , and two locations are introduced such that the distance ($t_1 < t_2$), we have $k(t_1) < k(t_2)$, which means that the relative income level is greater in t_1 than in ($y - k(t_2)$).

This can be expressed in two different budget lines which correspond to both distances t_1 and t_2 . However, we know that rent value r to distance t with a satisfaction level $u(r(t, u))$, is given by the slope of the budget’s straight line tangent to the indifference curve u . Therefore, we can see that the slope of the straight line which corresponds to t_1 , is greater than the slope that corresponds to t_2 , which means that rent value t_1 surpasses the one offered in t_2 ($r(t_1, u) > r(t_2, u)$). In this context,

the Thünenian idea is clearly present, in which the rent value decreases as the distance increases.

In conclusion, as distance increases, the net family income is reduced because of the increase in commuting expenses. If the satisfaction level is not altered, individuals must reduce the rent offer. This reduction is accompanied by the substitution of land of the composite good where $Q(t_1, u) < Q(t_2, u)$. “It means that the location rent theory subject here to an income logic which clearly gives it a “microeconomic basis”, in other words, a rationality concerning decisions made by families about location” (Abramo, 2001, p28) and it is the result of functionality actions, reason and “revealed will” of individuals within a market.

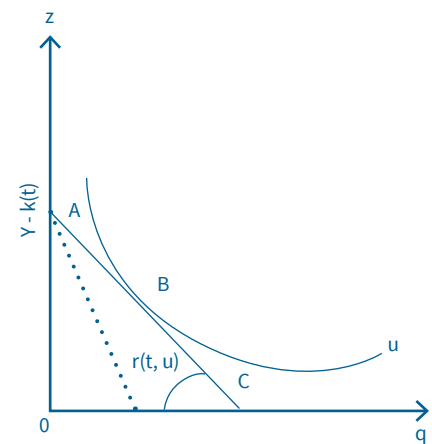


Figure 3. Rent offer for a given indifference curve and distance. Source: Abramo, 2001,p 26.

Urban Planning: The case of Bogotá

To analyze the urban planning of the city of Bogotá, it is necessary to take a historical tour of the different stages that have made Bogota the city we know today. Over the years, the capital city has had distinct epi-

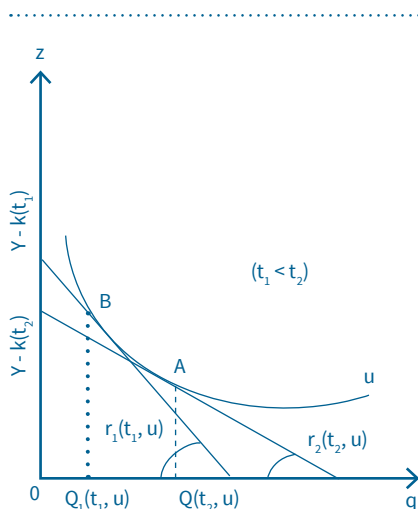


Figure 4. Modificaciones de la oferta de renta ($r(t, u)$) y del consumo de espacio $Z(t, u)$. Fuente: Abramo, 2001, 28.

centers of urban activity, understood as those geographical areas where the largest flow of economic activities is concentrated. In the 1940s, the main epicenter gravitated on Avenida Jiménez de Quesada, between sixth and ninth avenue. After a stage of war, this urban activity began to move north, along the Seventh and Tenth avenues. By

the 1950s, the center was revitalized due to the supply of land, accompanied by the opening of new roads, public spaces and the incorporation of large farms, as well as having, for this period, the highest population growth rates in the world. This coincided with the studies of the new airport, Tequendama Hotel and Esso's main headquarters, introduced a new concept of central location in the city, thus consolidating Bogotá as a monocentric city.

In the 60s and 70s, the shrinkage of the premises located in the international center generated a leap towards the north, by Seventh Avenue and Caracas avenue, (in Chapinero and Avenue Chile), in which a new center of business and financial activity would be formed, as well as generate, two development poles, one on 100th Street, with the construction of the World Trade Center, and another in Unicentro, around the commercial citadel.

The capital district at this time, was configured from the economic perspective "of the central place", which establishes an ordering of us-

es and a parallel ordering of prices and rents based on the price-distance relationship, which is nothing more than the order of rents, understood in the latter - in pragmatic terms - as the envelope of the different rents of Von Thünen's model (as shown in Figure 5) (Alonso, 1960).

Over the years and with the population increase, different land price pressures were created due to the scarcity of the land. In order to reduce saturation in the existing epicenters, initiatives were generated for the formation of urban activity towards the West, with fundamental aspects, such as the Bogotá Airport, along with the route that connects it with the international center and the formation of the National Administrative Center (NAC). These projects were the basis for the development of Colombia's largest urban development: Salitre City, a fundamental aspect of Bogotá's urban configuration, in which the price gradient is not only governed by a center (Von Thünen structure) but also this main gradient is affected by the proximity or distance of one of the sub-centres.

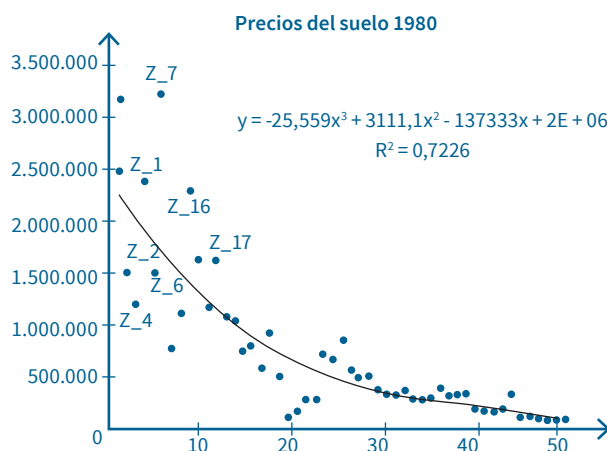
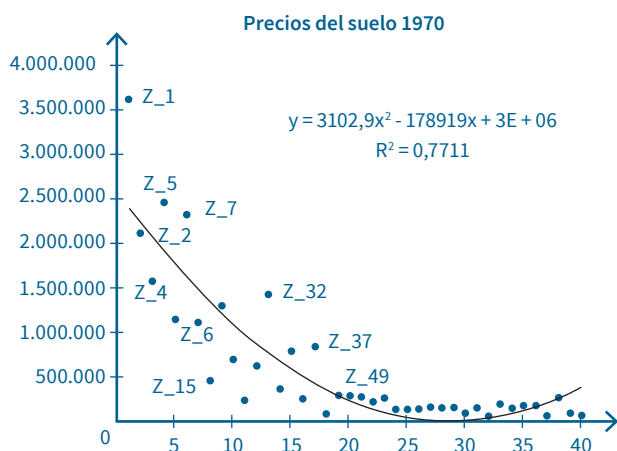


Figure 5. The prices of the city of Bogotá. Source: Araque & Vizcaino, (2009, p5)¹

1. Las Centralidades en el pot: aproximación desde el empleo recuperado de <http://institutodeestudiosurbanos.info/descargasdocs/eventos/seminarios-de-investigacion-urbano-regional-aciur/memorias-vii-seminario-aciur-2008/mesa-2/168-centralidades-y-aglomeraciones-de-empleo-en-bogota/file>

This dynamic of increasing displacement costs leads to the emergence of a new place of acquisition of goods.

The capital district is then configured, under a polycentric pattern, in which the city model is framed under a main gradient, dictated by the core center, and secondary gradients determined by sub-centres (see Figure 6).

This spatial duality demands, in terms of economic efficiency, the hierarchy of the centers and their functional specialty. The main central place will offer goods and services of high status and the other places will offer the ones of lower status. The offer of high rents of land of the first activities supports this configuration (Araque & Vizcaino, 2009, p4).

This distribution in the supply of goods and services indicates that the price differences are given in greater amount in the main center than in the sub-centers, and in turn, in the sub-centres more than in the rest of the city, the reason being that “Land prices are a good indicator

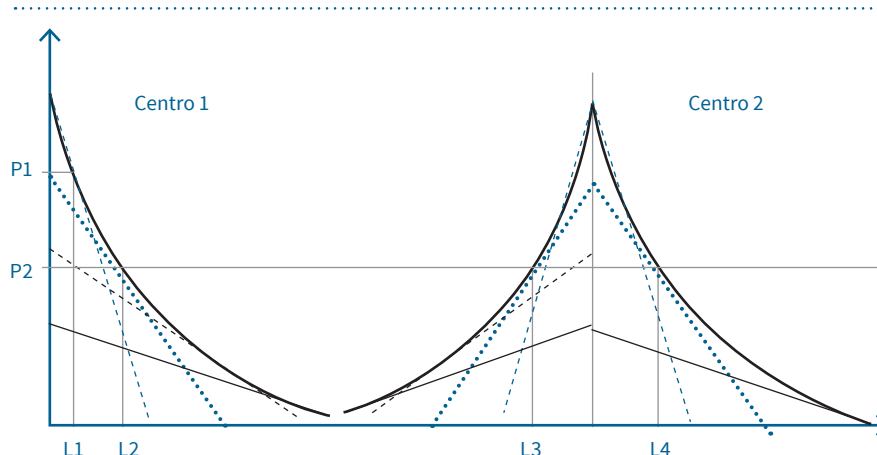


Figure 6. Prices of land in the polycentric City Source: Self Created¹

1. This polycentric city scheme marks out that there are local conditions which modify the general structure of the initial gradient. If the property is located in the city's major center it will have a different price than if it is located in a neighboring outlying centrality, that is to say, according to the function rent-distance, locations 12, 13 and 14 should have different prices in a monocentric city but not in a polycentric one where they would have the same price. Essentially, the gradient of each sub-center captures the local and particular conditions of each location.

of the central sites as well as the employment and hierarchy of the activities carried out in the central places “(Bourdeau-Huriot, 2004, p10). In Bogotá, price differences can be seen in the iso-distances to the city center (see figure 7), which is why it is important to demark the spatial structure of the centers and

sub-centres of the city. In this case, the following definition shall be taken:

“A center is defined as a continuous set of census sectors with higher employment densities and joins together at least E jobs. Thus, all areas immediately adjacent to a center have a density less than DE. In ad-

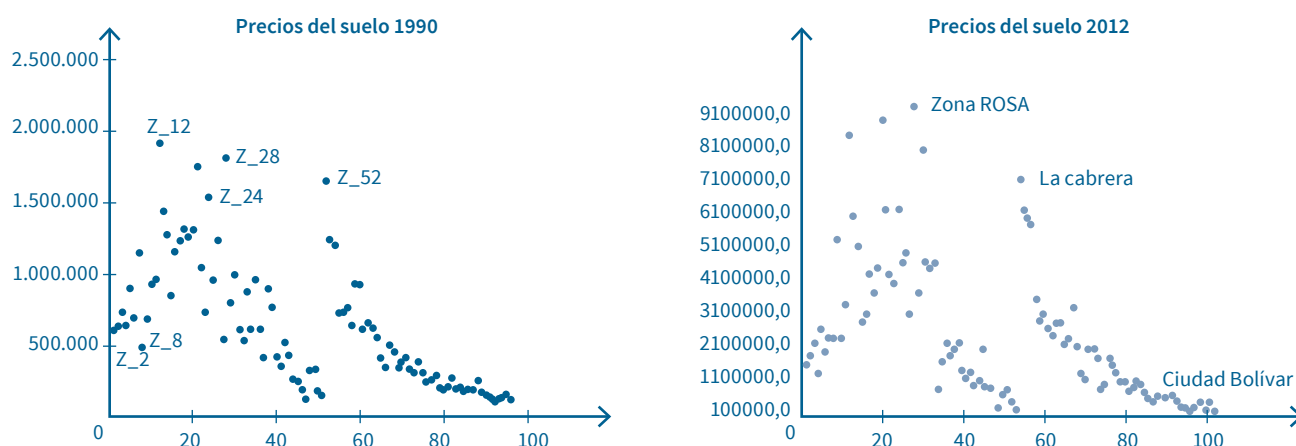


Figure 7. New Price Gradients of the city of Bogotá. Source: Araque & Vizcaino, (2009, p5)¹

1. Las Centralidades en el pot: aproximación desde el empleo recuperado de <http://institutoestudiosurbanos.info/descargasdocs/eventos/seminarios-de-investigacion-urbano-regional-aciur/memorias-vii-seminario-aciur-2008/mesa-2/168-centralidades-y-aglomeraciones-de-empleo-en-bogota/file>

dition, all areas with a high employment density will belong to a center, unless they have less employment in E and are isolated at the same time. That is to say that they do not share at least 4 miles of common boundary with other areas of high density "(Araque & Vizcaíno, 2009, p11)

In the same way, we will work under the methodology developed by Araque & Vizcaíno, (2009), which identifies the centralities according to the criteria of Giuliano & Small (1991) on the centralities identified in the city of Los Angeles based on the volume and the em-

ployment density of their transport analysis zones.

These methodological elements of G & S were adapted to the reality of the city, given the differences of Bogotá in its extension and concentration in comparison with the city of Los Angeles. This analysis was carried out using the 2005 employment census data and was established under the following parameters: Density greater than 10 jobs per acre and a minimum number of 267 jobs (average of the last employment decile of Bogotá). The georeferenced results of the developed methodology are presented in Map No 1

This methodology shows us a total of 36 centralities distributed mainly in three macro-territories of employment location:

1. 7th Avenue - Avenida Caracas-Autopista Norte. (Caracas Avenue- North Highway)
2. 13th Street - El Dorado Avenue
3. The axis between 68th Avenue and Boyacá Avenue.

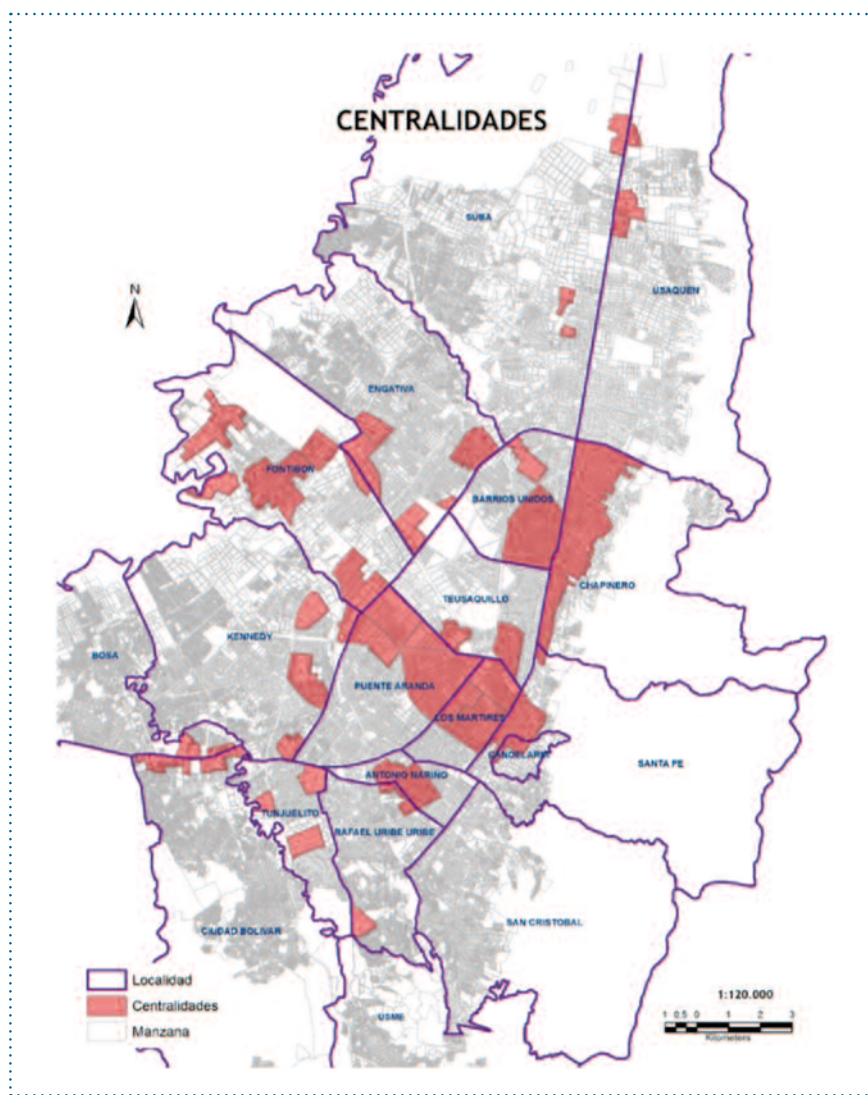
It is important to emphasize that two large territories where there is no strong mass of employment are Bosa and Suba.

There are low-income households and you can see low-employment areas and areas of mass expansion in sectors of dispersed nuclei.

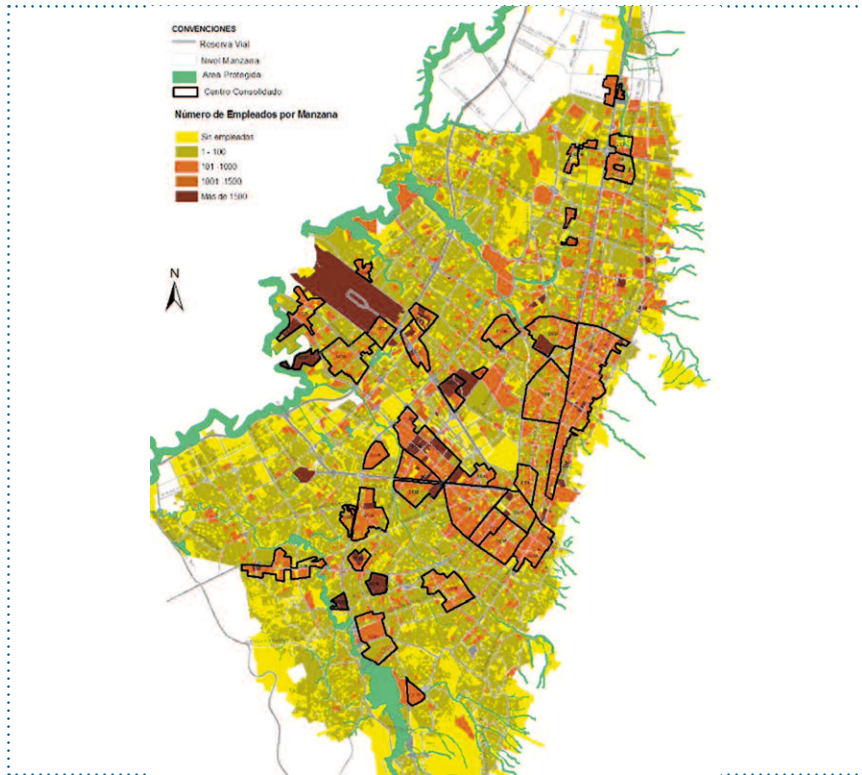
Map 2 confirms what is shown on map 1 which is the lack of centralities in low-income areas, especially in the western and southern parts of the city. In turn, it shows the aforementioned historical conformation of the known L of the first two passageways to the airport.

The dynamics of the city are seen in terms of the price gradient and the distribution of employment, but is reinforced with the distribution in terms of endowments and equipment since these areas are where there is a greater supply. In turn, they present a greater coverage of sites of interest, understood as those that fulfill some or all of the following characteristics:

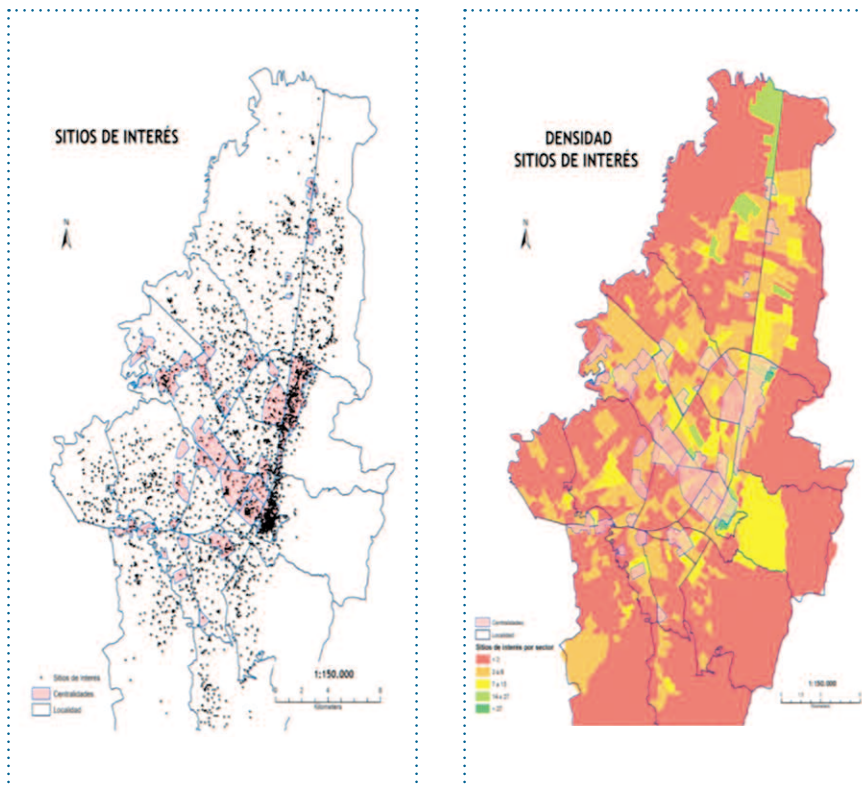
Housing and food, commercial service, sports, entertainment, education, health, public infrastructure, manufacturing and production (see map 3 and 4), which is framed so that the order of the city is supported under three great structures: "1. The main ecological structure, 2. Functional and services, and 3. Socioeconomic, referring to the centralities on which a set of strategic operations are established "(Araque & Vizcaíno, 2009).



Map 1. Centralities of the City of Bogotá. Source: Self Created.



Map 2. Number of employees per block. Source: Araque, Gutierrez & Quenguan (2016).



Map 3. Places of Interest Map 4 Density sites of Interest. Source: Self Created.

Conclusions

The model of territorial planning of the city of Bogotá until the mid-1980s was modeled on BidRent, where we could see that the international center and Avenue Jiménez were constituted as the main business center of the city exhibiting the highest prices land and shaping the price and income gradient of the city. On the other hand, the empirical evidence shows that the pressure of land prices and the exhaustion of the properties of the main center, accompanied by the construction of Salitre City, modified the main price gradient through the creation of sub-centres where the main gradient is affected by the proximity or remoteness to one of the sub-centres.

As for the city configuration based on a polycentric ordering model, it shows that the main center (which moved to 72) will offer high-ranking goods and services since the rent of land in these types of locations is greater than the rest of the city. The other territories will offer goods of lower status and this status will be expressed in terms of the income from the land, being the prices of the same an indicator of the central places of the city. On the other hand, the geo-referencing of the results of the Giuliano and Small methodology, allows growth of 36 centralities distributed throughout the city, distributed mainly in three macro territories: the axis 7th Avenue – Caracas Avenue-North Highway, the axis 13th Street - El Dorado Avenue, The axis between 68th Avenue and Boyacá Avenue.

It is important to bear in mind that the city is supported by three major structures namely: 1. The main ecological structure, 2. The functional and services, and 3. The socioeconomic, referring to the centralities on which a set of strategic operations are established.

Finally, it is shown how the centralities in Bogotá are fundamental places in terms of urban organization because they are where economic activity is concentrated and, consequently, the employment and supply of endowments, equipment and places of interest, which makes them a collective benchmark of business location and demand attraction

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