URBAN LAND VALUE DISTRIBUTION UNDER CONFIGURATIONAL SCRUTINY

Juçara Spinelli
Romulo Krafta

Program of Post-graduation in Urban and Regional Planning – PROPUR/UFRGS
Rua Sarmento Leite, 320, Porto Alegre, RS – 90050-170 – Brazil
Phone/Fax: (+51) 316-3145 – e-mail: propur@vortex.ufrgs.br or genuino@cpovo.net

ABSTRACT: In the present study were evaluated land parceling problems under aspects of spatial configuration related to land value (*lv*). Paradoxical cases occur in urban spaces, such as low spatial differentiation and high *lv*, or vice-versa. Determined urban areas are identified as having high centrality, with intense land use and occupation, and, therefore, high market value. Conversely, other urban areas are identified as having low centrality value, certain degradation, or lack of infrastructure and urban equipment, and, consequently, low *lv*. Empirical studies have proved satisfactory results in terms of the correlation between measures of configuration and *lv*. These studies verify the convenience of the models used to describe significant aspects of spatial differentiation. The complementation of the methodological proposal is identified, and other components of urban space are calculated (plot dimension, infrastructure, normative aspects, etc.). These are determinant measures that characterize the local factor associated with measures that determine the morphological differentiation. This differentiation demonstrated that land value distribution, besides following centrality, depends, in greater or lesser extent, on the local factor. The results obtained, through a *model that combines measures of centrality with local characteristics*, approached reality because the model incorporated a greater number of variables which allowed the verification of correlated socioeconomic and spatial matters related to parceling, value, and configuration.

INTRODUCTION

The aim of the present study is to detail some elements that interrelate and influence both urban land configuration and urban land value, having as case study the city of Bento Gonçalves, RS/Brazil.

Often, land value is determined by plot dimensions, and the greater the plot, the greater the price. This assertion loses its validity when market values are attributed to the parceled land of a city, whose values are usually defined empirically by the real estate market which, in its turn, takes into consideration not only plot dimensions but also other urban elements, such as centrality/segregation, locational opportunities, use and occupation of land, and market conditions, which in their turn are influenced by the “law of supply and demand”.

The adopted variables comprise the morphological differentiation (centrality) and locational opportunities (local factors) that, combined, allow the verification of the factors that interfere in it, from this point on not only empirically, but via a specific methodology that leads to the simulation of verifiable results through morphological analyses. The statistical processing, via models of prediction, led to the recognition of discrepant values of urban land (overestimated and underestimated ones) that reflect intensely in the configurational aspects of the city.

SPATIAL CONFIGURATION AND LAND VALUE

The relation between spatial configuration and urban land value is a result of values of centrality and measures that reveal locational privileges.

The **configuration** encompasses the situation of the *urban spatial structure*, that, as Echenique et al (1975) elucidates, comprises the result of a process of allocation of physical objects and activities in determined places within a given area. Thus, two interdependent processes can be distinguished: on the one hand, one that allocates activities to places according to their functional relations to other activities, and to the restraints imposed by physical stocks (adapted spaces and channel spaces, of circulation), and, on the other hand, the location of this physical stock in terms of adapted spaces (land and buildings) and channel spaces, providing the necessary locational conditions for the activities. Therefore, the spatial structure could be understood through the disposition of the elements present in the *city's cask*, i.e., by a concrete *physical structure* governed by a set of activities which creates flows and movement and which comprises another structure, the *functional* one.

The *physical structure* of a city is defined by its *open spaces* and by the *built form*. According to Gebauer (1981:3) "the open spaces can still be decomposed in *open public spaces*, which constitute specifically the urban space (streets, plazas, and green areas), and in *private spaces*, conditioned by the division of land (plots and squares). The built form acts as a mediator between these two spaces."

The *functional structure* comprises the part of logical organization of the spatial structure that is the chief responsible for the processes of change and movement. Wagner (1995:68) states that "this logical construction of urban space has, along with the shape, the content, which is expressed by its functional structure. It is the definition of the activities that will animate the urbanized spaces, which is also called land use." Urban land use can be identified in different ways, according to the different analytical aims. In general, it is classified as residential, commercial, of services, industrial, institutional, among others. This classification occurs both in result of the differentiation given by the types of activities themselves, and of the distribution of spaces that allow the allocation of these activities (the stocks). In this manner, in the urban scale, when one is in search of spaces for the allocation of certain activities, these spaces can have their value increased, in result of the supply, since the availability of plots, besides the available infrastructure, limits considerably any localization of activities. Both structures (physical and functional) combine, and their elements interact systemically, one with the others. Quaroni (1977:15) defines the urban structure as being "a combination of elements, a whole formed by interconnected phenomena in a such a way that one element depends upon the others, not capable of being what it is, unless in view of its relation to the others." Hence, these combined elements end up by revealing a certain *spatial differentiation* derived from the configurational patterns of the urban matrix (characterized by the distribution of streets, plazas, and green areas), from the configuration of the parceled private spaces (squares and plots), and from the typology of built spaces, sometimes evenly distributed, other times completely disorganized. The activities (land use) continue to reinforce this differentiation, not only through the power of attractiveness they exert on the system, generating different patterns of movement on the physical structure of the city, but also through the potential for changes in the functional picture itself, originating a kind of zoning, first natural, of the distribution of each typology of land use, and afterwards legitimated and induced by the norms of the zoning of uses. This allows the identification of high levels of development in the concentration of buildings, mainly in areas with varied of uses; what may demonstrate a certain spatial differentiation and diversification of urban land values.

The **urban land value** is interdependent in relation to the configuration both in the *micro-spatial scale* (local) and in the *urban macro-spatial scale* (global). In the local scale the specific characteristics of the parceled land, as the plot sizes, consolidate certain typological patterns of construction or of land use. Thus, the urban land value may present an increase in its value due to geometrical aspects of the site. Plots of equal dimensions located in adjacent areas may have different values in result of the size of the stretches, which may favor or not a better utilization of the land, specially as to ‘constructability’, enabling more openings, ventilation, and insolation.

The infra-structural factors may also be related to the land value via the valorization of the total area and via the potentiality of urban development, induced by better conditions of accessibility, water supply, sewage, illumination, to name a few.

In the global scale, spaces of greater accessibility, animation, and centrality confront with other spaces more segregated, with less availability of access, and, therefore, with fewer quantity of attractors of movement. In this case, normative elements may be related to the land value via the distribution of zoning of uses and occupation (regulated by urbanistic indexes – of land use, rate of occupation, minimum ideal quota) that influence the good use of the land in terms of the type of activity and ‘constructability’.

In face of the above described suppositions, the hypothesis upon which the research is based supposes that it is possible, through models (of centrality and local factor), to describe urban land value relating it to elements of spatial configuration.

URBAN MODELING

Urban modeling consists of a comprehensive instrument of great importance that aids in the simplification of reality so that it can be described, simulated, and understood. Thus, it becomes possible to adapt to the modeling matters concerning local characteristics, morphological differentiation, and land use, since the urban phenomenon is inserted in a complex set of elements (or factors) that, interrelated, affect one another and configure new spaces. The process of (re)configuration, therefore, is dynamic, and the land value, inserted in the urban context, is also influenced by these factors. The following models have been used to describe urban reality.

Intraurban Configurational Models

Model of spatial differentiation

In morphology, one way to describe urban spatial differentiation may be achieved through measures of accessibility and centrality. Ingran (1971) verified that variations on the levels of accessibility are related to variations in populational densities and land value, since accessibility refers to the capacity to reach, that is to say, it is the measure of nearness between two points. Alternatively, the accessibility is related to the ability of a system of transportation of low costs and/or having an effective method of control of the distance in between different locations.

Studies carried out by Hillier et al (1993) suggest that a natural movement is created by the structure of the city itself and consists of the complex formed by the movement of pedestrians and vehicles. The integration of areas occurs in consequence of the accessibility proposed by the matrix and by the volume of activities, which are the attractors of movement. However, in this study the accessibility of the network was measured solely by the analysis of the system of roadways and its most accessible spaces, through the verification of the connectivities (point at which a line crosses or intercepts another), taken from the reduction of the urban reality to an axial map which comprises the representation of the roadways matrix by a system of straight lines. Each segment of street that interrupts a rectilinear section is reduced to a new axis or axial line.

Krafta (1994), when analyzing the city via its spaces (public and private), its built forms and activities, identified minimal paths (more accessible), besides urban portions with greater centrality. These variables served also as a component of analysis in relation to the identification of the land value distribution, since the development of the concept of spatial differentiation allowed some types of measures that initiated with the concepts of accessibility, relative asymmetry and centrality, and afterwards its abstraction, which today permits new concepts and models for the measures of convergence, opportunity, and spatial potentiality.

The measure of centrality enables the verification of the tenor of attractiveness of a localized urban activity. Considering that the city may also be defined in the scope of the whole system, then called "general centrality", for being the result of the interaction of all individual centralities.

Krafta (1995) argues that "generally, one can expect that the measure of centrality approaches the distribution of commercial activities and services, for two different reasons: the first, *structural*, would be that commercial activities need to be in more accessible positions of the system and, consequently, willing to compete for better locations, paying more for them; the second reason, *descriptive*, is that the measure of centrality itself differentiates the activities, according to its power to attract. So, the most attractive ones, provided they are located in accessible points, will converge to high measures of centrality."

The components of centrality are basically the attractors and the attainability:

- The *attractor* is the urban activity located in itself, desegregated in its minimum discrete unity. Once the identification and quantification of all attractors are done, the second stage is to estimate the degree of attractiveness that each activity exerts. In most cases of application of the models, the way in which to estimate the attractors of a system is to obtain a product such as:

$$A_i . a,$$

where: A = the quantity of space allocated to the activity i, and a represents the degree of attractiveness of this activity. From this definition derives a urban system characterized by a set of located urban activities, quantified according to their importance and attractiveness.

- The *attainability* comprises the relation between each of the activities and the remaining components of the system. Each single urban activity is attainable to all the remaining ones, as long as there is a system roadways and means of transportation in a proportion equivalent to the respective attractiveness. Thus, the activities have mutual influence, according to their abilities to attract and spatial position in the system. Combined, attractors and attainability form the components of centrality which, in its turn, can be directly affected by certain elements that may redistribute centrality either via restriction or incentive of the allocation of certain activities or via obstruction or hampering of accessibility. Among these elements, the outstanding ones are the urbanistic regime, the zoning of use, and the realization of public buildings.

Urban phenomena, by comprising part of an extremely complex reality, are not always easily articulated to centrality. For this reason, the measure of centrality may be gauged to describe the intensity of action of these different phenomena, as in case of correlation with the land value.

The Local Factor Model

In order to verify the distribution of land value, besides measures of centrality, we propose the study of the local characteristics of urban land. This study is done through the variables that characterize some locational privileges, such as plot dimensions themselves, the infrastructure and urban equipment available, and the existing urbanistic norms that regulate the index of land utilization and the zoning of uses. The measure that determines locational privileges allows the verification of the way in which a localized parcel, a street, or a given area of the city, and presents the best potentiality of habitability. Urban habitability refers to the basic conditions needed for the performance of activities (residential, trade/services, industrial, among others). These privileges are also named *local factor*.

The model to verify the local factor is based on the consideration that the places with better habitability are those that have a good network of infrastructure and equipment, plot dimensions that favor ‘constructability’, making possible the utilization of the façades and a level of insolation that does no harm to the construction nor to the environmental comfort; and, still, having an urbanistic index favorable to the maximum utilization of the plot with no local impact and/or to the neighboring buildings.

In the urban context, some elements that affect centrality directly also influence the local factor. Examples are the allocation of infrastructure, normative aspects that animate defined activities, or, still, urbanistic indexes that promote specific patterns of occupation in terms of the capacity of support in a given locality. In this manner, the local factor gradually established patterns inherent to the characteristics of a given area in a way as to influence the land value. To verify the local factor, the following formulation was used:

$$LF = [f(i)^a + f(ia)^b + (tl)^x)],$$

where: *LF* = local factor, *f(i)* = calculated function of infrastructure and equipment, *f(ia)* = calculated function of urban regulation (indexes of utilization), *(tl)* = average of size of plots per street, and $^{a,\, b}$ and ^{x} = constant parameters that indicate the weight of each variable in the system.

The result is equal to the amount of locational privilege given by the sum of the functions gauged by the value of the constants.

The component elements of the local factor may be described as follows:

a) <u>Infrastructure and urban equipment</u>: A value one (1) was considered for presence, and zero (0) for the absence of each adopted variable (public illumination, paving of the roadways, garbage collection, and public cleansing), which was used in an average for the verification of how each element influences the local factor (according to total or partial presence, or absence of variables).
b) <u>Dimensional aspects</u>: Average size of plot per street or axial. It serves as an indicative of the pattern of agrarian structure and as an agent that allows inferring about the socioeconomic conditions of an urban locality.
c) <u>Normative aspects</u>: Influence of urban regulation (*index of allowed utilization* – ***ia***) according to the zoning of uses.

The results of the application of the model of local factor were correlated to the land value and analyses to verify the spatial distribution of both factors were made.

Model of simple and multiple prediction of land value

The studies which take into consideration the local factor and its manifestations in the context of the square, district, and city, imbued with spatial differentiation, are still incipient.

Conventionally, urban land value has been discussed and analyzed under the light of economics, as it comprises a property that yields revenue.

Studies conducted by Chapin (1977) show that the land use and value are determined by the real state market as a negotiable product, subject to forces of supply and demand. Hence, urban land is on the market competing for the consumer’s money, not considering the complexities of these acting forces. The land price on the market varies according to the type of functional area where it is located and according to its relation to other plots within a given type of area of uses, that is to say, each parcel would have with the others a single physical relation. Since in each community there are a variety of land uses, each parcel represents the center of a set of unique and complex spatial relation with the social and economical activities centered in other parcels. The market gives to each combination of spatial relations a corresponding value which determines, in great extent, the amount offered to the plot as center of this combination. Thus, some enterprises are more valuable than others for residential use, since they have greater network of commerce, schools, job centers, recreational possibilities, and the like. The existence of a land value, as the one established by the alternatives of use and development, leads to its extreme utilization. For this reason, the use of a specific parcel is finally determined by the operations of the market forces, by the price paid, and by the decision to know which of the alternatives will provide most benefit. Thus, it becomes evident that the systems of use, intensities, and value, are extremely interconnected and conditioned by their localization.

In relation to localization, Guttenberg (1960) developed a theoretical approach to urban structure and city growth as a concept of organization, what he calls "the effort of the community to overcome distance". This would have its development based on the sense that human interaction becomes the reason for reducing distance to its minimum, accepting implicitly that the interaction is the fundamental determiner of spatial structure. In this case, the structure of land value in urban area starts to have considerable influence on the way in which individuals use it for different ends, in various locations and densities. The numerous planning orders for the change of use of parcels, specially those of corners, and the continual requests from all sectors to change the use of one category to another, are manifestations of the market forces of the urban land. In relation to land value it is also considered that, when calculating the cost of a site, adjustment factors are applied to value per unity of façade that take into consideration the different measures of back and the influence of the corners. The valuation of buildings are estimated separately, via references to the proportion of depreciation applied to the original costs, to costs of transportation, and via other means. To be highlighted is that this economic view takes into account much more market characteristics than locational ones, although these are considered implicit to the distribution of land value.

In relation to other aspects that contribute to land valorization, not only from an economical point of view, Diefenbach (1995) comments that this valorization will depend not only on the demand, but also on the externalities provided by the supply of urban public services, of means of collective consume, in short, of different elements of infrastructure provided, above all, by political action, usually represented by the municipal public authority. Therefore, the need to produce space clashes with the speculation of urban voids. The most popular example of private production of urban areas is the parceling, a product of a policy of authorities of basic sectors. Very often this policy favors real estate speculation, which causes the urban voids. Additionally, space valorization is differentiated, inciting social segregation. Brazilian cities undergo an urbanization similar to the peripheral countries, where the unequal distribution of infrastructure and equipment results in differentiated social valorizations in the territory.

Consequently, one is able to verify that parceling and land value are influenced both by internal factors, such as specific aspects of the parcel and of its localization, and by external factors that, by interacting, cause differentiated effects on the plots, their activities, and their consequent market value. The identification of the distribution of land value apparently depends upon factors embedded in it. As already mentioned, there are factors of different natures and of difficult quantification for the degree of abstraction in which they are in – as, for example, the valorization via socioeconomic level of the first owners of a parceling, who can induce an increase or reduction in the valorization of the land; the pre-determined inclination of an area or its change by the dwellers, etc. – that were considered external to the model, even though they are somewhat relevant in the analyses of the present study.

The considered factors are quantifiable and may have both intrinsically local characteristics, as the ones expressed by *local factor,* and systemic characteristics that comprehend the urban level, as the ones expressed by *centrality*. The relevance of it is that the *local factor* indicates where the spaces with the best potentiality for habitability are, what ought to influence in the land value through the tendency of valorization. In its turn, *centrality* describes to us where the spaces of greater accessibility, diversity, animation, and integration are, and that, such as the local factor, ought to influence the land value and its distribution in the city, through its capacity to aggregate urban characteristics that identify spatial opportunities, expressed via morphological differentiation.

Thus, the model admits that the land value distribution may be verified through the *regression* analysis between the known land value (Official Register of Real Estate –Bento Gonçalves) and the results of the measures of centrality and local factor. The regression model is used because it is attentive to the measuring of the association among the variables in a more complete way than the correlation coefficient, since, according to Andrade (1989:438) this model, besides measuring the interrelations among the correlations, also estimates the parameters of causality among them.

By means of *simple linear regression*, the individual association, between land value and centrality and between land value and local factor, is verified. The equation for the analysis of each of the associations is expressed as follows:

$$y = m_x + b,$$

where: y = land value, m = coefficient that correspond to each value x; x = centrality/local factor and b = constant.

The results of the application of the equation are relevant since they permit to verify, a priori, if there are discrepancies between the proposed land value (real) and the estimated value by the model (calculated), both by centrality and by local factor.

Once the land value was established for each of the cases (centrality and local factor), it was the aim of the present study to scrutinize its behavior in face of the two measures associated. In this case, for the number of independent variables, the *multiple regression* is used, whose equation resultant from the analysis is expressed by:

$$y = m_1.x_1 + m_2.x_2 + b,$$

where: y = land value, m = coefficient that corresponds to each value of x, x_1 = local factor, x_2 = centrality, b = constant.

The results of the application of the equation of multiple regression allowed the verification of the presence of discrepancies between the known land value (real) and the value estimated by the model (calculated). Moreover, the comparison of the spaces in which the result was normal became relevant, i.e., whose values resulting from the application of the model did not appear much different from the real value.

CASE STUDY: BENTO GONÇALVES – RS, BRAZIL

Urban Characteristics

Bento Gonçalves is located in the South of Brazil, in the NE region of the state of Rio Grande do Sul. It is a medium size municipality, with a population of approximately 93,000 inhabitants, 83% residents in the urban area, and 17% in the rural area (IBGE, 1991). The municipal district is situated in a mountainous region, in an altitude of circa 600 meters. The cities' topography displays considerable oscillations.

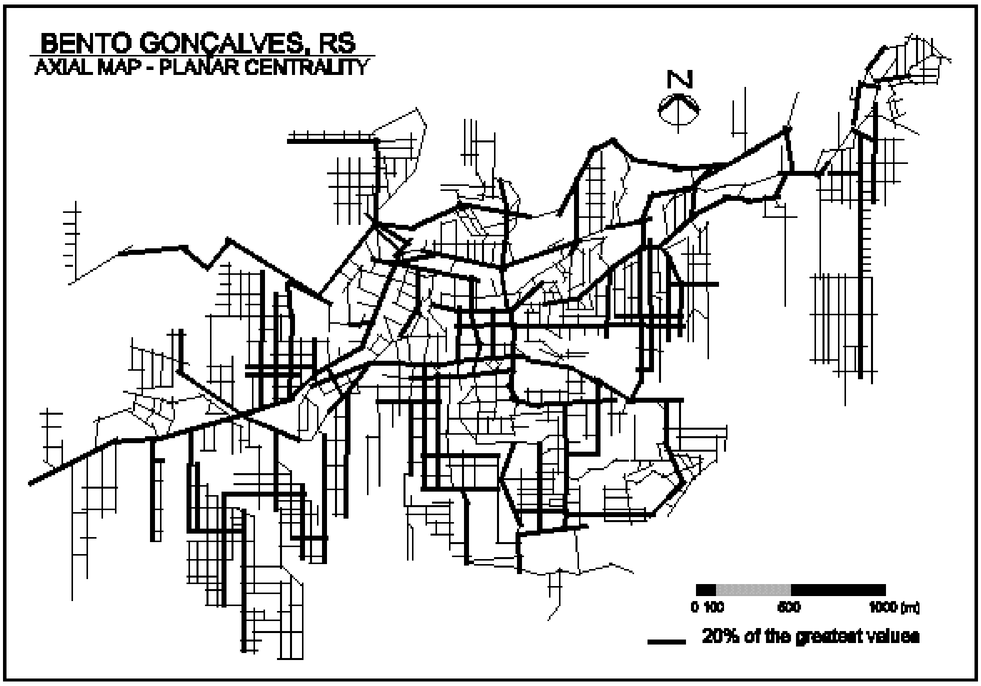
Historically, it has a well defined central area to which converges an intensive land use, not only in terms of residential use, but also in commercial, of services, and even industrial uses. In this area one encounter the greatest urban animation induced by the functional structure (land use) and by a relatively plane topography, not very common in the city characterized by considerably irregular areas. Generally speaking, the growth of settlement occurred around this center and urban development has outlined a profile that follows a certain linearity when observed from the SW-NE direction contouring, in an elongated way, the superior part of the central area, as if it were an extension of it. In this part, as in the central area, commercial activities are intense what favors the increase in local urban animation. Outside the central area the land use is basically residential, except in the specifically industrial areas where there is a predominance of sizeable industries. This simplified description of the city has its relevance based on the fact that it is necessary to recognize the urban characteristics, such as disposition of roadways matrix, use, occupation, infrastructure, topography, and so forth, to analyze the situation of the parceling, the spatial differentiation, and the distribution of land value.

Application of the models

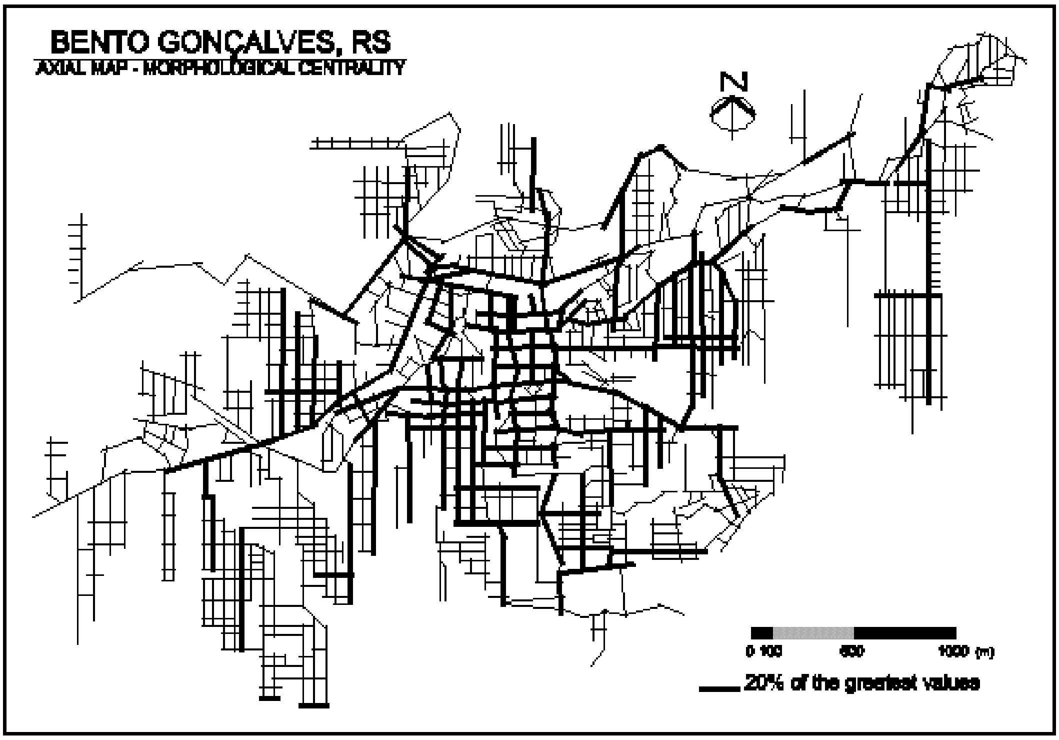
The map of the roadways matrix of the city in a 1:10,000 scale served as basis for the axial representation whose lines where randomly enumerated, producing a network of 787 public spaces, serving for the following morphological measures: *planar centrality* (PC) – considers only the influence of the roadways –; *morphological centrality* (MC) – analyzes the roadways matrix and the buildings, and *real centrality* (RC) – which incorporates, besides the above mentioned variables, the weight of activities, gauged by linear regression being attributes parameters equivalent to **1**; **14.4**; **2.92**; and **2.28**, respectively, for residential, commercial/service, industrial, and other uses. Having the results of these measures, the same were classified in ascendant order, indicating a spatial disposition (by axial line) from the spaces that indicate greater accessibility and centrality to the less accessible and segregated ones.

The comparison of the measures permitted to verify that while the PC (representing the hierarchy of the roadways matrix or accessibility of the network) has a behavior that characterizes spaces reasonably distributed in the system, with certain conformity in the central area and with the SW-NE axis; the RC showed a distribution of central spaces on the SW axis, an evident concentration in the central area of the city and just a discontinued tendency in the NE direction, linearly decreasing from the historical center to the periphery. Along with this finding, it is possible to emphasize the influence of the normative aspects on the urban system, this influence being able to transform the configuration of the city, not only due to the presence of buildings and activities but, mainly, due to the differentiates normative distribution (zoning of uses) that guides, through the urbanistic indexes, to a localization of the centrality much more concentrated than that naturally evidenced by the roadways matrix and strengthened by the buildings.

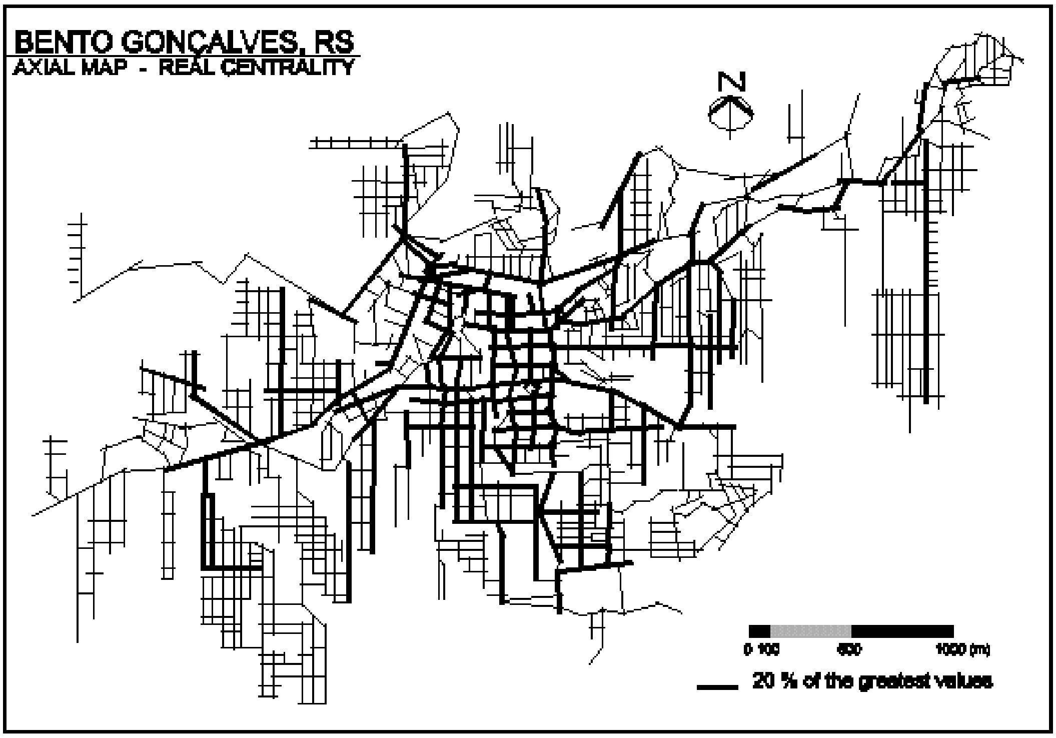
The result of these measures may be visualized in the following maps where 20% of the greater values of each measure of centrality are represented (Figure 1).



a) Planar Centrality



b) Morphological Centrality



c) Real Centrality

Figure 1: **Maps of the measures of Centrality (20% of the greatest values)**

Simultaneously to the determination of the morphological measures, it was made the calculation of the local factor (Lf) whose result indicates where the privileged spaces for habitability are, independently of their position (more or less central) in the system.

The variables of the Lf were gauged by linear regression whose adopted constants were **3.60**; **31.63**; and **0.0007**, respectively, for infrastructure and equipment, index of utilization and size of plot. Through the simulation it became evident that when zoning uses and specific normative indexes are attributed, for different spaces, also distinct locational privileges are induced. Thus, urban regulation, in a certain extent, defines the local factor being relevant in the historical center of the city, where the plots have relatively homogenous sizes and a locational situation extremely privileged. The greatest values of Lf were verified in the historical center and in the NE axis, being little displayed in the SW direction, differentiating from the values of the measures of RC. These values are represented in the following map which shows 20% of the greatest measures of the local factor (Figure 2).

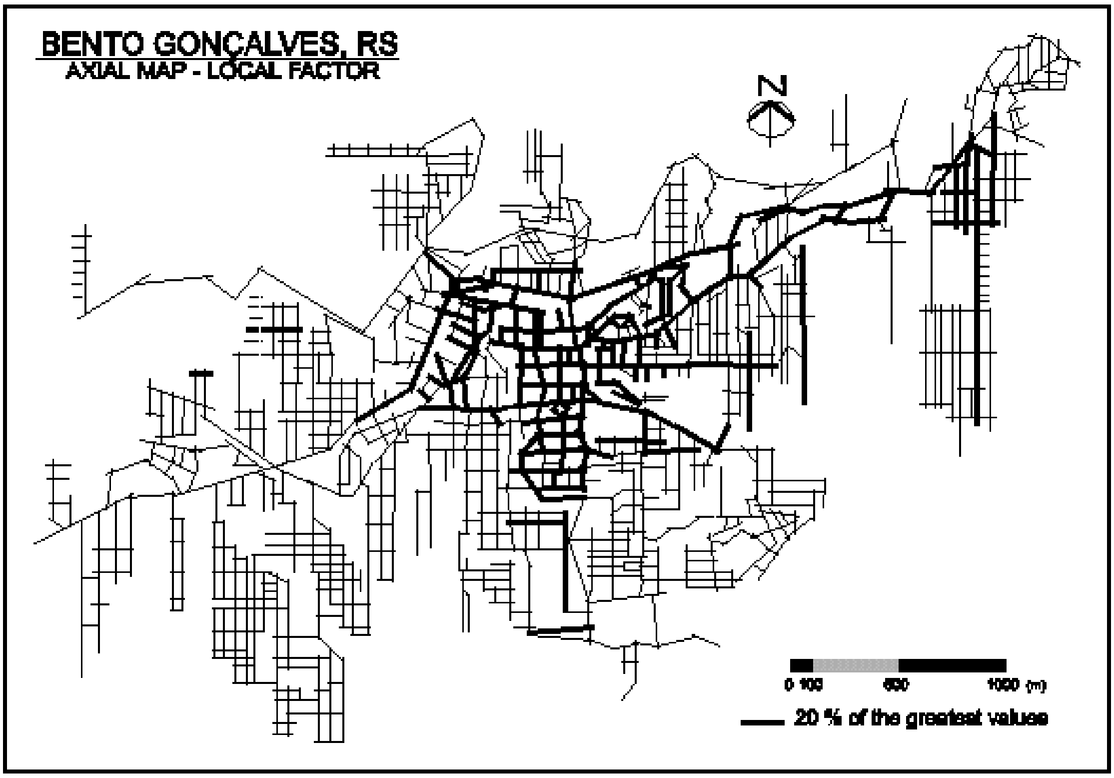
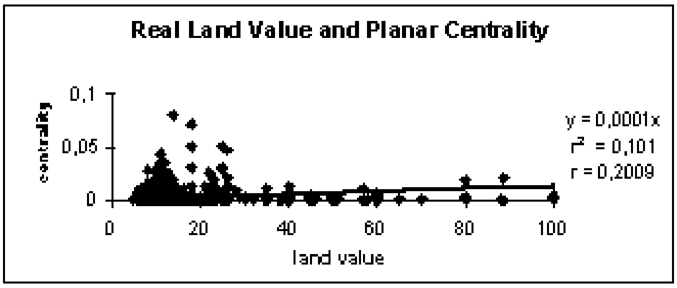
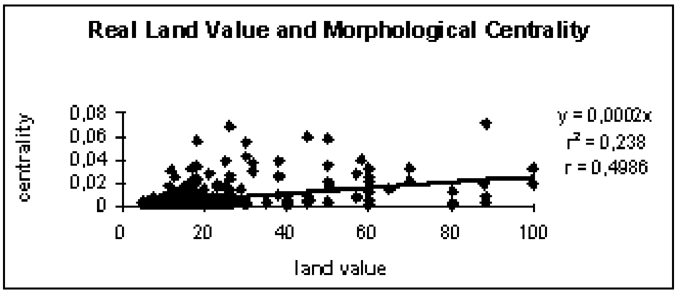


Figure 2: **Map of the Local Factor (20% of the greatest values)**

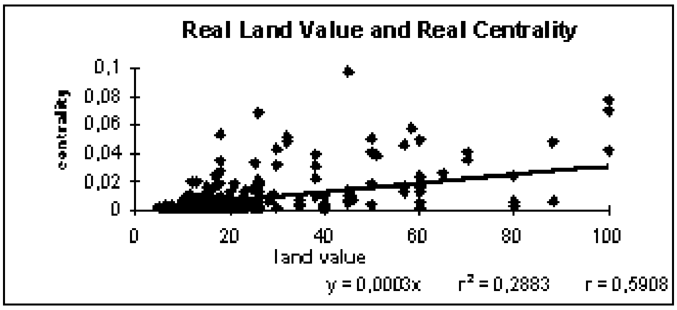
After the identification of the measures (centrality and local factor), these were correlated with the known land value (real), and the values presented in the diagrams below (Figure 3) and summarized in the table (Table 1) are the results.



a) Diagram of dispersion between RLV and PC

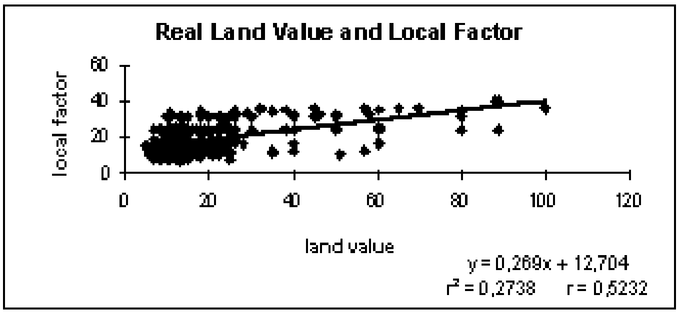


b) Diagram of dispersion between RLV and MC



c) Diagram of dispersion between RLV and RC

Figure 3: **Representative diagrams between measures and the real land value (1)**



d) Diagram of dispersion between RLV and LF

Figure 3: **Representative diagrams between measures and the real land value (2)**

Table 1: **List of correlations between the measured values of PC, MC, RC, LF, and the real land value (RLV).**

Measures and RLV	Correlation
PC	0.2009
MP	0.4986
RC	0.5908
LF	0.5232
RC and LF	0.6610

The results indicate that the individual measures are not well correlated with the land value, although the RC has proved itself prominent in relation to the remaining measures probably due to the fact that it incorporates a greater number of variables of spatial scope, proportionally gauged, that influence the land value. A better value is verified on the associated measures (RC and Lf), increasing the correlation to 0.66, which indicates that when the two factors are interactive, there is an approximation of the measures to the land value.

To verify the level of importance to each measure in the distribution in the land value there have been used statistical models of simple and multiple prediction.

The calculated land value (CLV) had as basis the following equations:

Simple linear regression between RLV and RC: CLV (RC) = 756.71 * RC + 14.51
Simple linear regression between RLV and LF: CLV (LF) = 1.017 * LF – 0.317
Multiple linear regression between RLV, RC, and LF: CLV (RC/LF) = 573.99 * RC + 0.63 * LF + 4.09

The application of these equations had as results the following determination coefficients (r^2): RLV and RC = 0.34; RLV and LF = 0.27; and RLV, RC, and Lf = 0.43.

The coefficients have proven to be low, on the other hand, the RC manifested the greatest degree of influence among the individual variables. An increment in the value of r^2 was verified in the case of the associated measures. The application of the multiple equation allow the estimation of the CLV whose values were plotted in the following diagram, together with the RLV, for the purpose of comparison (Figure 4).

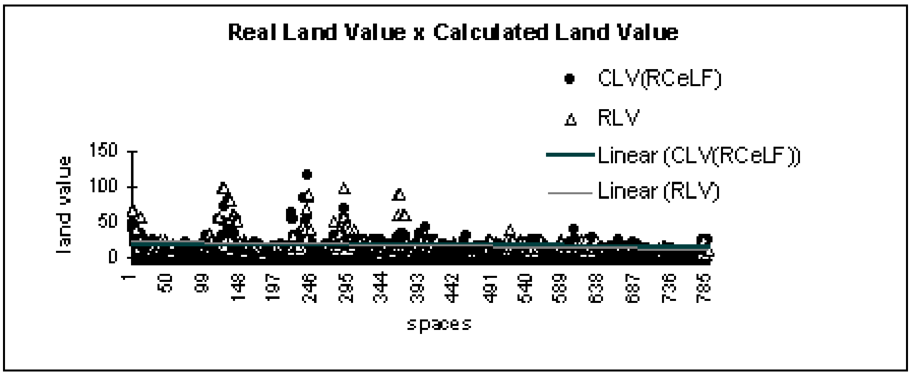


Figure 4 – **Diagram of dispersion between real and calculated land value**

RESULTS AND DISCUSSION

One of the facts that favored the low values of r^2 are the remote points of the tendency line. In order to identify and analyze the disperse points, a new plotting and analysis of the coefficient of correlation (r) and determination (r^2) were carried out, in a total of 21.72% of the system. The following diagram illustrates the distribution of the spaces in the system after the removal of the remote points (Figure 5).

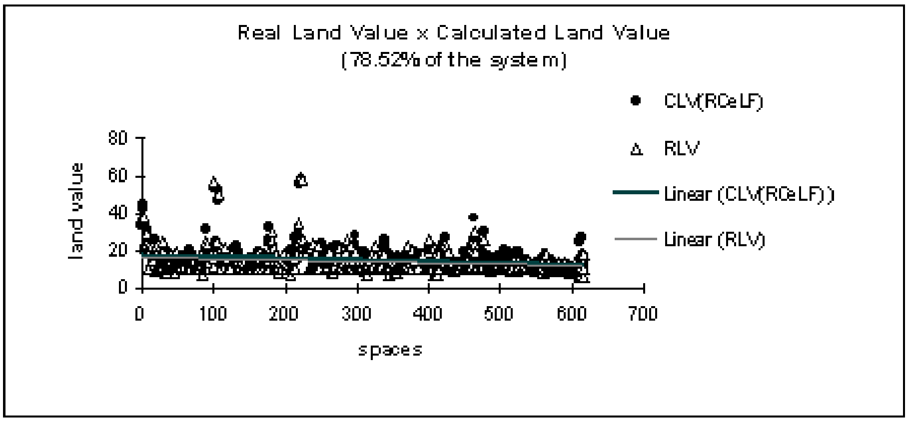


Figure 5 – **Diagram of dispersion between real and calculated land value in 78.52% of the system**

The following table shows the results obtained (Table 2).

Table 2: **Coefficients of correlation (r) and of determination (r^2) for the analyses of each variable and the land value in 78.52% of the system**

Measures	**r**	**r^2**
RC	0.75	0.57
LF	0.57	0.33
RC and LF	0.83	0.69

The results demonstrated that the RLV, in relation to the individual measures, presents greater correlation with the RC confirming a greater influence of centrality over the land value. The associated measures presented a satisfactory result ($r = 0.83$). In the case of the coefficients of determination (r^2), the results indicate that the model corresponds to reality in almost all system (approximately 80%), although discrepant cases needed detailed analyses.

Of the total of discrepant cases, 55% were overestimated and 45% underestimated by the model in relation to the RLV. An analysis of the place allowed to verify that the discrepant cases follow a certain logic where high values of land would be being attributed to the places of high RC and Lf. The opposite would also occur. It was verified that, although following the measures, there were variations in terms of values (extremely high in relation to the RLV in places of high RC and much more inferior in segregated places). On the other hand, some cases with low values of centrality and local factor were identified as discrepant where the RLV is elevated in relation to the characteristics of centrality and local factor, forming islands of land value that deviate from the logic (verified in the place and by the model). To this fact we infer the action of variables external to the model, generally abstract, instable and of difficult quantification, as economic issues and changes in the socioeconomic level of a certain urban locality.

The spaces with values were spatially located showing the places where the real land value is overestimated or underestimated by the model (Figure 6).

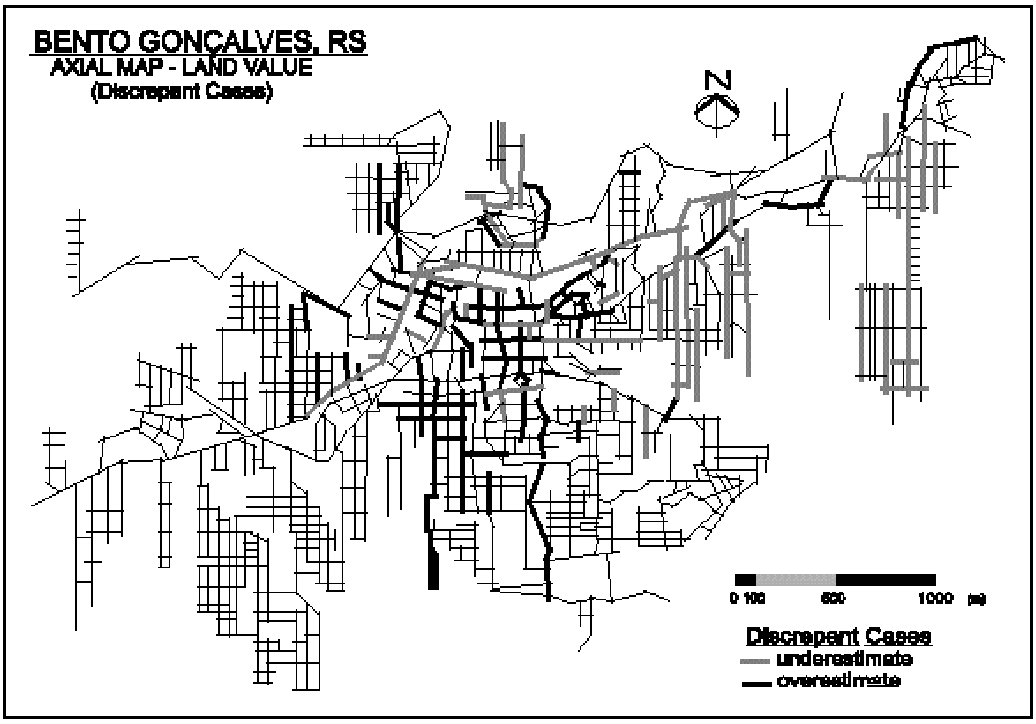


Figure 6: **Discrepant cases of the land value in Bento Gonçalves – RS – Brazil**

From the map, we observe that the majority of the land values underestimated by the model are found alongside the superior part of the historical center, yet comprising the commercial zone and some spaces of the NE sector, whose uses are basically residential (dense and medium density). To be emphasized is that a great deal of the underestimated values comprise spaces of high centrality, but not all have high local factor, what may have contributed to these discrepancies (see maps of RC and LF).

In relation to the overestimated values, one observes that most are found in the historical center (commercial zone) and in its surroundings, in the residential zones, of institutional and industrial integrated protection, corresponding the high values of centrality and local factor, in most cases.

Of notice are discrepant cases that show low values of RC and/or LF and also low land value, as may be observed in the center-north portion of the system, where underestimated and overestimated values appear in this residential zone.

In the center-south portion, there appear cases overestimated in relation to the model, where low and medium values of centrality and local factor were identified, what would demonstrate a relatively low value to the urban land. Nevertheless, high values of real land were verified, which must be associated to zoning of uses (residential, zone of protection of the sources, and of institutional protection), and indexes of utilization that, although limiting 'constructability', may be favoring the increase in the value by depriving high density, nowadays a relevant factor, when a great deal of urban residents seek getting away from very dense areas.

The remaining discrepant cases were verified in the extreme NE sector, in residential zones, favored probably by the same reasons inferred in the center-south cases.

The behavior of the urban land value distribution in the W sector practically did not present discrepant cases. Perhaps due to the vast protection zones and to the occurrence of relatively low local factor, which would still be promoting an occupation a bit restrict and less dispute for the urban spaces in the portion of the city, although some spaces present high centrality, mainly by comprising important roads of local and regional connection.

CONCLUSIONS

The proposed modeling, although in experimental stage, proved adequate to the treatment of data, specially in approximately 80% of the system, allowing the managing of variables, the simulation of the land value, and the identification of the urban characteristics in differentiated patterns of space. The following points summarize the conclusions pertinent to each identified measure:

➲ Measures of centrality: they were used to describe characteristics of the urban matrix and component elements, although only the RC was analyzed as a parameter that interferes in the land value, since it constitutes a more complex measure than those which consider solely the roadways system and/or the built forms. Thus, it was possible to verify that centrality interferes in the land value not only by the attainability property but, mainly, due to the attractiveness revealed by the different land uses. In this case, the urban regulation revealed the induction of specific typologies of uses to determined places, in a way to consolidate significant spatial differentiation in the urban system.

➲ Measure of the local factor: the adopted variables for the identification of the LF may have been insufficient to describe in a more particular way these characteristics. This fact may be translated by the low correlations (0.52 and 0.57) between the measures that identify local characteristics and the land value. Another fact that may have favored the low correlations refers to the dimensions of the plots. In all spaces, the dimensions were reduced to an average size (average plot size per street or axial), what may have conceal the local reality through the generalization, that did not allow the verification of LF individually in each urban plot, but only in each space (axial line) represented in the system. Besides, an adjustment of the variables or the incorporation of others, as for example physical characteristics of site (topography, land type, etc.), perhaps could favor the description and refine the results, even though this probably would imply an exaggerate amount of time needed for the collection of data, not ensuring significant changes in the results.

➲ Combined measures: the final product was similar both to the empirical reality and to the real values (proposed by the Official State Register – Section of Bento Gonçalves), and allowed to identify places whose land values are over or underestimated by the model. On this matter, the inferring that the normative factors (specially the zoning of uses) exert strong influence on the land value still needs to be further detailed and confirmed. Moreover, the finding of discrepant values (over and underestimated) leads to the idea that factors external to the model, such as market conditions, are still to be identified as well as verified for a future discussion about the distribution of the urban land value and its relation to the spatial configuration.

The morphological and statistical control of land use and value constitutes another tool to aid in urban planning allowing the test of the impact of changes in the values of centrality, local factor, and urbanistic indexes on the land value, through urban simulations.

REFERENCES

ANDRADE, T. A. (1989) Métodos estatísticos e econométricos aplicados à análise regional, in *Economia Regional: Teorias e Métodos de análise*. Haddad, Paulo Roberto (org.), Fortaleza, BNB, ETENE, pp. 427-507.

CHAPIN, F. S. (1977) *Planificación del uso del suelo urbano*, Oykos-Tau S. A. ediciones, Barcelona, 431p.

DIEFENBACH, Z. A. (1995) *Uso do solo urbano no Bairro Patronato – 1966-1992*, Santa Maria, RS. Santa Maria, UFSM, 58p. (Monograph of Specialization)

ECHENIQUE, M. et. al. (1975) Modelo espacial de "stock" y atividades, in *Modelos de Analisis Territorial, Coleción de Urbanismo*, Oikos-Tau, Barcelona, pp. 93-146.

GEBAUER, M. A. (1981) *Urban Morphology*. Oxford Polytechnic, Department of Architecture & Town Planning, Joint Centre for Urban Design, 11p.

GUTTENBERG, A. Z. (1960) *Urban Structure and Urban Growth*, in Journal of the American Institute of Planners.

HILLIER, B. et. al. (1993) Natural Movement: or, configuration and attraction in urban pedestrian movement, in *Environment and Planning B: Planning and Design 20*, p.29-66.

IBGE (1991) *Censo Demográfico do Rio Grande do Sul*.

INGRAN, D. R. (1971) The concept of accessibility: a search for an operational form, in *Regional Studies*, vol. 5, Pergamon Press, pp. 101-107.

KRAFTA, R. (1994) Modelling intraurban configurational development, in *Environment and Planning B: Planning and Design 21*, pp. 67-82.

KRAFTA, R. (1995) *Centralidade e uso do solo*. PROPUR/UFRGS, 6 p. (explanatory text on the study of urban centrality and on land use elaborated for the City Hall of Porto Alegre, SPM)

QUARONI, L. (1977) *Progettare um edificio: otto lezioni di Architettura*; Milano, Gabriele Mazota editore.

WAGNER, M. L. (1995) *Descrição e desenho da cidade para a expressão de valor*. Porto Alegre, UFRGS, 194p. (dissertation)