Revista Brasileira de Cartografia (2015), Nº 67/8 Edição Especial 26º CBC: 1607-1625
Sociedade Brasileira de Cartografia, Geodésia, Fotogrametria e Sensoriamento Remoto
ISSN: 1808-0936

Mapas conectando o Brasil e a América do Sul
Gramado-RS-Brasil • 03 a 07 de agosto de 2014

PARAMETRIC MODELING AND VISUALIZATION IN DECODING OF COLLECTIVE VALUES: FROM ABSOLUTE TO RELATIVE VALUES

Modelagem Paramétrica e Visualização na Decodificação de Valores Coletivos: De Valores Absolutos a Relativos

Ana Clara Mourão Moura

Universidade Federal de Minas Gerais – UFMG
Escola de Arquitetura, Laboratório de Geoprocessamento
Rua Paraíba 697, Savassi, Belo Horizonte – MG, CEP 30130-140
anaclara@ufmg.br, geoproea.arq.ufmg.br

Received on October 06, 2014/ Accepted on May 1, 2015
Recebido em 06 de Outubro, 2014/ Aceito em 1 de Maio, 2015

ABSTRACT

The work herein provides a general discussion on the issues involved in urban and landscape planning, with an emphasis on the visualization. The paper reviews some of the challenges involved in the planning using visualization tools and Geographic Information Systems. The purpose is to present a motivation to think about choices users make while applying methods of geoprocessing analysis for, somehow, most of users just apply tools but do not question their meaning. A proper conceptual base is a way to avoid following new tools without really contributing to new methodologies and not using the real potential of Geographic Information Systems. We have been living a new paradigm on urban planning, changing from authorial design to the decoding of collective values, using parametric modeling to understand, define and control values and expectations in urban land use. The responsibility of making urban proposals clear has as purpose not only making citizens understand plans, but also to instruct them on an urban common landscape, which is the role of the visualization. It discusses concepts on visualization and presents a methodological proposal to transform representation from absolute into relative in order to support the decision-making in urban landscapes. The paper herein presents techniques to construct a diagnosis of potentials and limitations, to propose maximum constructive envelopes for plots' occupation, and to promote the visualization in order to share the decision with the community, mostly on the Parametric Modeling of Urban and Natural Landscape approach.

Keywords: Parametric Modeling, Urban Design Teaching, Urban Visualization.

RESUMO

O trabalho apresenta discussão geral sobre questões relativas ao meio urbano e planejamento da paisagem, com ênfase na visualização. O artigo revisa alguns dos desafios envolvidos no planejamento usando ferramentas de visualização e de Sistemas de Informações Geográficas. O objetivo é o de apresentar uma motivação para pensar sobre as escolhas que os usuários fazem quando aplicam métodos de análise em geoprocessamento porque, de alguma forma, a maioria dos usuários não questiona sobre os significados dos modelos e de suas representações. Uma adequada base conceitual é uma forma de se evitar o uso de novas ferramentas, mas sem contribuir de fato em novas metodologias e sem de fato utilizar os potenciais reais dos Sistemas de Informações Geográficas. Estamos vivendo um novo paradigma no planejamento urbano, mudando do desenho autoral para a atuação através da decodificação de valores coletivos, usando a modelagem paramétrica para entender, definir e controlar valores e expectativas no uso do solo urbano. A responsabilidade em tornar claros os propósitos da ocupação urbana têm como objetivo não só fazer os cidadãos entenderem os planos, mas também como instruir em aprendizados de se começar a entender como é composta a paisagem urbana coletiva, o que é um papel da visualização. Discute conceitos em visualização e apresenta propostas metodológicas para transformar a representação de absoluta em relativa, para dar apoio a tomada de decisões sobre a paisagem urbana. Discute técnicas para se construir diagnósticos identificando potencialidades e limitações, para a proposição de envelopes máximos construtivos para a ocupação de lotes urbanos e para promover a visualização que favoreça o compartilhamento de decisões com a comunidade, sobretudo a abordagem da Modelagem Paramétrica da Paisagem Natural e Urbana.

Palavras chaves: Modelagem Paramétrica, Ensino Urbanismo, Visualização Urbana.

1. INTRODUCTION

This paper provides a general discussion of issues involved in urban and landscape planning, with an emphasis on visualization. The paper reviews some of the challenges involved in the planning using visualization tools and GIS (Geographic Information Systems). The purpose is to present a motivation to think about choices users make while applying methods to GIS analysis for, somehow, most users just apply the tools but do not question their meaning. A good conceptual base is a way to avoid following new tools without really contributing to new methodologies and not using the real potential of Geographic Information Systems.

Parameterization means establishing limits, targets, and in the case of urban landscape to propose acceptable envelopment or wrappings for the composition and construction of architectural volumetric shapes. It is urban occupation managers' role to establish these limits, because they are the ones who will create the relation between society and collective awareness in urban occupations.

Thus, within acceptable limits, it is considered as the architect's action to use his creativity to propose, within the maximum envelopes, the materialized expression of his project. The action of the architect can be individual, giving each project a character and an identity, but what connects it with the context and makes it perform in society is the respect for shared parameters. This means proposing the order within disorder, because maximum envelopes allow a set of homogeneity, while the individual expressions within these envelopes will allow natural diversity of architectural responses to every situation.

While the architect expresses his creative proposal while working delimited by the the envelopes, the urban planner who establishes the parameters of this maximum envelope acts as a decoder of the collective will. In this sense, the role of the urban planner as an authorial planner, proposing his point of view, tends to be reduced and he is expected to work in a very important societal task: to identify and to set values to parameters, which will promote the landscapes expected by society.

The urban planner, as a decoder of the collective will, has as a fundamental tool: parameterization. Far from being understood as a rationalization of the landscape, in fact, parameterization is the establishment of shared criteria that reflect what is valuable for a society.

What is questioned, in this reflection, is if citizens, when voting for a zoning and for a table of urban parameters, are aware of the landscape to be generated by those values. As a proposal to deal with this challenge, a set of steps are structured in a methodological script:

- Significant investment in visualization of information, starting from initial data structuring until to the promotion of interface platforms that create a common language among technicians, administrators and citizens able to interact and make decisions using a shared code of communication (MACEACHREN et al. 2004);

- Investments in social media for community consultation, allowing the participation of individuals interested in exchanging values and expectations about the collective landscape being shaped. Such participation has the role of building knowledge and spreading information that keeps the system evolving. The use of social media through crowdsourcing mapping (in which data are collected without, necessarily, the specific response of the citizen to urban issues, in a passive contribution) and through VGI –

Volunteered Geographic Information actions (in which a citizen voluntarily responds to specific questions about the reason for the research, in an active way) (CILLIERS & FLOWERDAY, 2014; GOODCHILD, 2007);

- The application of spatial analysis models based on reproducible and defensible criteria that promote representation and simulation of different views and values on the urban landscape. Investments in geo-processing technology that favors modeling, including models of information integration (Multi-criteria Analysis), models to verify validity and defensibility of responses (Suitability Analysis) and evaluation models of the carrying capacity of environments (neighborhood impact, carrying capacity studies and analysis on territorial resilience).

-The development of models based on Geodesign processes (STEINITZ, 2012). The process of Geodesign means structuring a script of spatial management that begins with characterization of reality, which involves the production of different perspectives on the territory according to different actors and values, it steps ahead to possible landscapes simulation and it acts mainly in the propositioning phase. Miller (2012) advocates "Regarding the future of Geodesign, it is as Abraham Lincoln, Buckminster Fuller, Alan Kay, and Peter Drucker all said, 'The best way to predict the future is to create it'."

-Along with Geodesign, Planning Support System – PSS (HARRIS & BATTY, 1993) structures actors' actions and processes, proposing a system where feedback steps are clearer as well as the verification of certain points, evaluation and validation of results in different stages and system integration into other contexts. The system puts those actions in a transparent plan in order to inform and plan the different agents' responsibilities and conditions and action modes.

Finally, all the stages of the proposed procedures are integrated; understanding values, expectations and acceptable limits; getting Parametric Modeling of Territorial Use results, which consciously reflect the landscape expected by society, which will then see it as a collective asset and as a value to be defended.

In the paper herein the emphasis is on the role of visualization in the decoding of collective values process. In fact, to act as the decoder and not only as the author of urban transformations, the urban planner should follow the steps in the use the potentiality of GIS: visualization to decode the community values, Geodesign to structure models and present a system of goals and steps to support decision-making, Spatial Analysis based on models and simulations in order to understand challenges, and VGI to involve the community and receive their opinions. In this sense, it is presented the first step, visualization processes to decode values from and principles to the community and prepare the Parametric Modeling of Territory Use of Urban Landscape construction.

2. THE ROLE OF VISUALIZATION AND ITS SIGNIFICANCE

Dynamics inherent in the urban space impose the need to work with a systemic vision of the whole. The representation of spatial elements that are interconnected and, at the same time, are individually identifiable, brings along the development of the cartography and Geographic Information Systems as vehicles of visual communication of analysis and proposals for urban issues. A thematic mapping of territory that is expressed through graphical representation must not ignore the principles of graphic semiology, in the most different means of information visualization. The mapped topics are portraits of certain aspects of reality, and they can focus on qualitative and quantitative questions.

In order to adopt participatory planning, and to work in interdisciplinary teams, the capabilities of the visual communication of cartography are a common language, which enables exchange of information and opinions.

The importance of cartographic visualization must be recognized in its most different nuances (bidimensional, three-dimensional and in simulations of four dimension) as the language that translates current trends of systemic visions on urban issues, in addition to enabling management and analysis of the complex and dynamic databases.

It is a language that enables the community to monitor diagnostics and proposals of interventions that are consensual among planners and users, and that are within the concepts of landscapes transformation capacity and resilience and on land use and land cover changes.

The cartographic representation and the use of means of visual representation are, by their very nature, the most eloquent form of communication and exchange of information and comprehension among individuals. Much more expressive than verbal, written or numerical communication, visualization favors the vision of the synthesis of a spatial phenomenon or occurrence.

According to Bertin (1967) and also Bonin (1975), the visual communication is developed from the general to the particular, because the apprehension of the whole is set in the first process of observation. This is the opposite of other means of communication in which the observer goes from the particular to the general, such as the case of writing, in which the reader understands the words, creates the sentences, and then builds understanding by summing up the parts.

The cartographic visualization process as "Open Work" (Opera Aperta), in the sense advocated by Eco (1962), due to its synthetic nature, which promotes construction of the synthesis of information, but also makes possible an analytic decoding of its composing elements, from the general to the particular. Thus, visual communication is initially monosemic in the sense of "where", "how", "how much"; but the comprehension of "why" and "what if" must be provided to develop its understanding and decoding. That makes it polysemic. The support of geo-technologies enables this polysemy, because visualization allows, according to Manovich (2004), an endless variation of images, which means the construction of comprehension within the logic of "Open Work".

Translating the visual information, McCormick et al. (1987) define that investments in visualization in territorial representation allow us "to see the unseen", because it makes perceived aspects that are not explicitly clear, and reveals correlations as data is input on spatial representation.

Andrienko et al. (2010) advocate that all citizens are potentially space-time analysts, although different actors act at different levels in the process, which provides support to solving space-related decision problems through enhancing human capabilities to analyze, envision, reason, and deliberate.

Visualization also serves an educational role because it instructs understanding on occurrences in territorial phenomena. According to Snyder (2002), citizens change from a reactive citizen (passive information receiver) into a proactive one (provider of information and consumer of information in order to build new information and positions).

The issue of visualization as the basis for interaction among the different actors in decision-making must be very well proposed in order to avoid the use of visualization as a way to hide erroneous logic and/or invalid data. Some GIS users invest much in the aesthetic appeal of visualization, which enchants but can be deceiving. The purpose is to transform representations from absolute into relative and facilitate the decoding of the data.

2.1 Composition of territorial information visualization – from absolute representation to relative representation

The well-structured and planned visualization is the basis for interaction among different actors in decision-making. However, in order to be a shared code where users meet to interact and dialogue, it is necessary to follow some principles for the transformation of absolute values into relative ones.

This is due to absolute data, regarding its territorial position, quantitative values and mode of representation, does not often offer the user full understanding. On the other hand, when data is treated in a relative way, compared to the existing conditions, the understanding of its meaning is closer to the language of the different actors. Visualization of data, which will be understood as information, must go through the process of transformation from absolute into relative, on the scales of measurement, values, representation, and territory.

2.1.1 Visualization by adjustments to measuring scales

The construction of adjustments in the scale of measurement is an important procedure in preparing data for visualization when the goal is combining variables. Working with standardization of scales allows qualitative data (descriptive or nominal) to be presented quantitatively (by numbers), according to evaluation or ranking of its qualities.

The collection of data nature is divided into nominal, ordinal, interval and ratio:

- Nominal - it is qualitative or selective. As an example, the use of land and land cover is cited. The legend components cannot be presented as hierarchical, except when they are presented according to some judgment of value. It cannot be said that vegetation cover is more or less important than the urban area, except when it is in accordance to a specific classification, for example, assessment of the land value to implement the electric power transmission lines.

The nominal scale representation does not allow the application of arithmetic operations since it is not possible to say, for example, that vegetation cover is the double than that of urban areas. It is only possible to apply mathematical operations if the legend components are transformed into numeric values that have a level of relevance (significance?) to an analysis.

- Ordinal - components can be presented according to greatness or preference, but, as in the previous class, it is not possible to apply arithmetic operations, but only to assess frequency and modal class. It is based on the hierarchy of positions, and it is not correct to say that second place means the double value of first place.

- Interval - ranges are known and each observation can be given an accurate numeric value. Zero point is arbitrary and does not indicate absence of measured characteristics, as for example, temperature. It is infinite in extent and density between two positions. The use of arithmetic operations is limited to linear transformations. Parametric statistical techniques can be applied.

- Ratio - ranges are well known and zero is a real source. The case of the number of inhabitants per municipality can be mentioned, as the components are listed, classified and measured. It allows the wide use of the arithmetic operations and of the applications of parametric statistical techniques.

The transformation of nominal, ordinal and interval scales to the ratio scale allows the application of arithmetic operations and parametric statistical techniques. Components are placed in a ranking represented by numeric values. This ranking is established according to the distribution of the level of relevance of the variable for the purpose of the investigation. This is the transformation of absolute values into relative ones, being the relative values numeric values between the minimum and maximum positions. Thus, data undergoes a preprocessing process, aiming at the standardization that will enable the study of variable correlations in evaluating spatial phenomena.

2.1.2 Visualization according to adjustments in the scales of values

Each variable has its representative values and that are according to its intrinsic characteristics. Representation of the distribution of average income values, number of years of study, temperature, slope, accessibility indexes, for example, have quite different distribution graphics and numbers of maximum and minimum. The behavior of the variable is its signature in the reality.

However, variables' absolute intrinsic values often have low significance in understanding. If it is informed, for example, that in a location there is a slope of 20 degrees, its understanding depends on the use they establish for that place and the creation of a comparison with previously known situations. This means turning absolute data into relative data.

The transformation process of relative data into absolute data is quite simple, and it means to set values in a range in which the beginning and the end are controlled (Figure 1). In mathematical terms, it means to normalize data. Once sets of data are standardized, it is possible to make comparisons between them and understand their behavior individually and as a member of a set.

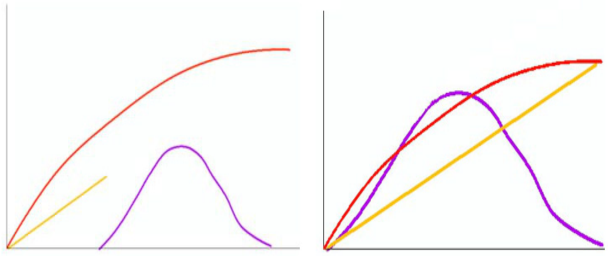

Fig.1 - Standardization of data to facilitate comparisons in visualization - adjustments of initial and final limits in distribution curves.

2.1.3 Visualization of models that are simplifications of the reality

Visualization of an event or territorial occurrence necessarily goes through processes of simplification. The reduction is required since reality can only be represented according to conceptual, temporal and methodological simplifications. Visualization is a model of representation of reality which symbolizes a way of understanding – conceptual simplification; temporal response to a condition –temporal simplification; and reduction in main variables representing a complex system – methodological simplification.

Visualization is a reduction that represents the reality according to a point of view, among many other possibilities. This simplification is made necessary in a time when excess of information puts the user in a maze of possibilities. McCormick et al. (1987) warned that excessive data generated by different systems and origins would have interpretation limitations due to the lack of tools. The same concern was shared by Andrienko at al. (2007), who wrote about the risk of the labyrinth of information in counterpoint with the absence of data.

Thus, models which are simplifications of reality, if presented as defensible and reproducible criteria, adjustable to the users' interests, are much more eloquent and favor the understanding of information. The level of information´s detail should be structured so as not to lead the user into a wrong understanding of reality, imagining landscapes that cannot be said to have that shape.

In some cases, it is necessary to represent possible landscapes as thoroughly as possible, as in the simulation of the reconstruction of landscapes which process will be the responsibility of an entrepreneur, and the final result can be stated (Figure 2 up to Figure 5). In this case, accurate representation is relevant, as in the example of the recovery of mined landscapes by processes promoted by companies to support decision-making (MOURA & AMORIM, 2007).

Fig. 2 - Example of mining landscape to be recovered.

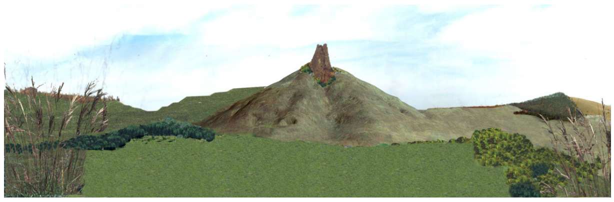

Fig. 3 - Recovery proposal of mining landscape, with simulation process represented according to two principles: simplified simulation of the vegetation cover and complex simulation, by fractal logic, on the hillside to be recovered.

Fig. 4 - Detail of fractal modeling representation of hillside to be recovered.

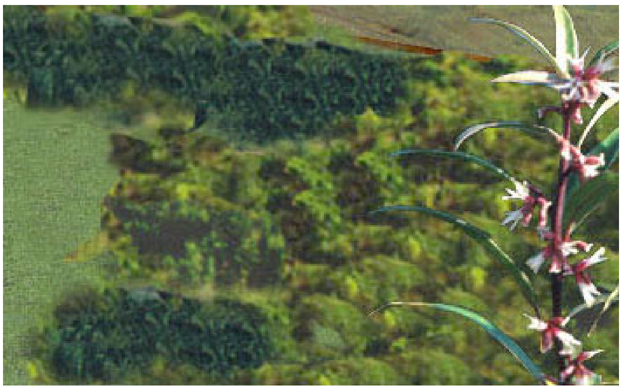

Fig. 5 - Detail of simplified modeling of vegetation cover, by repetition of pattern.

It can be observed, in the example of the recovery of a mined landscape, which purpose was the realistic simulation, that there was a project of transformation on the landscape. The representation was made possible by visualizing the outcome of the future landscape. Even so, two types of modeling were built: a realistic one and a more simplified one. The realistic modeling was employed in the area of the hillside, the principal element of the territory's recovery, through fractal modeling based on choice of grains, textures and colors. The simplified modeling was performed by repetition of patterns, representing vegetation, once that variations in the landscape project proposal could still occur.

In other cases, it is important not to apply textures, because it cannot be stated that they are, in fact, representations of the future landscape, because one cannot say that they will actually happen. It is the case of the simulation of future landscapes in an urban environment by applying symbolic representations in order to make the design more realistic. However, it can, in fact, create false expectations, illusions or misinterpretations by users. Visual attractiveness employed in the simulation can mislead observers since digital technology allows you to create beautiful landscapes that have not yet been built and it cannot be stated that it will be exactly that way. In this situation, it is strongly recommended not to use the textures, but a representation as simple as possible, in the form of maximum envelopes that respond for what can be actually stated about the future landscape (Figure 6).

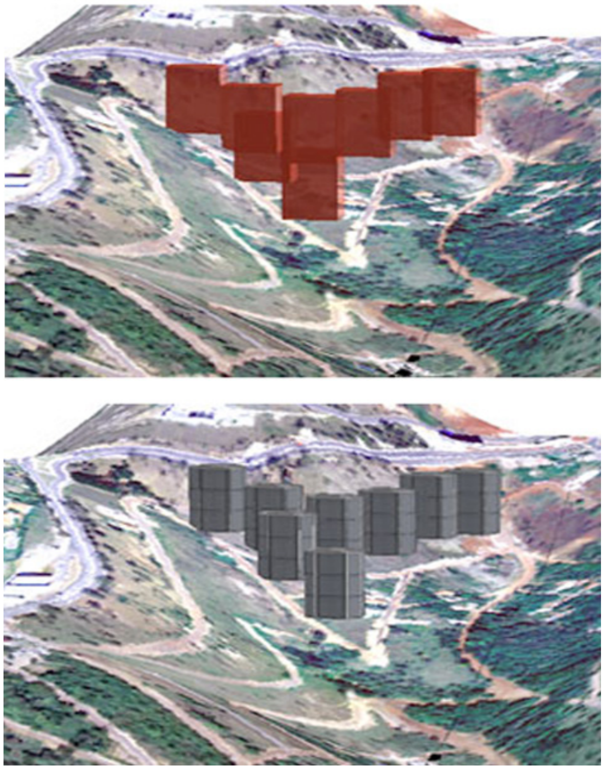

Fig. 6. Landscape simulation representing only maximum envelopes versus representation of textures.

2.1.4 Visualization by adjustments to territorial scales

Cartographic and geometric precision often need to be adjusted in favor of a more generalized representation which facilitates the simplification of information. This is the principle that governs topological cleaning in cartography, when there is the function of representing an element by its basic components, and excessive details are abandoned.

Cartographic generalization should be well structured so as not to lose the element's essence. It is, then, the specialist user's role to understand the main components of the element represented and to define acceptable limits of generalization.

It is proposed that, in studies of visualization by adjustments of scales of representation, the selection of territorial units which allow for comparison of attributes. It is the reduction in territorial units of integration that is commonplace in comparisons between different situations. It is the option to be chosen, for example, when there are multiple layers of information at different scales of resolution, and it's necessary to choose a scale and convert all other layers to the one chosen.

This is also a necessary choice when comparing landscapes. According to Pensa (2013), it is an acceptable option to choose a scale or mode of representation of a variable in the territory, and this reduction must be used as the basis for data to be evaluated in order to achieve a basis for comparison. This is the case, for example, in the interest of the comparison between an existing volumetric shape in the past and a new transformed volumetric shape along time or simulated for the future. It would not be possible to promote visual comparisons between objects "a" and "b" since they do not have a basis in common, but if the user opts for the adoption of the basis of "a" and simulates the condition of "b" from "a." (Figure 7 and Figure 8). This means not representing the volume in absolute, but in the relative terms.

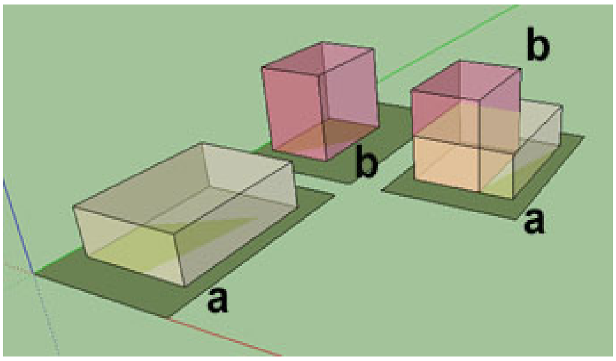

Fig. 7 - Absolute representation of volumes. For example: Volume 'a' is in fact constructed, and the volume 'b' is the maximum envelope defined by the legislation. The comparison between them is hampered by absolute representation.

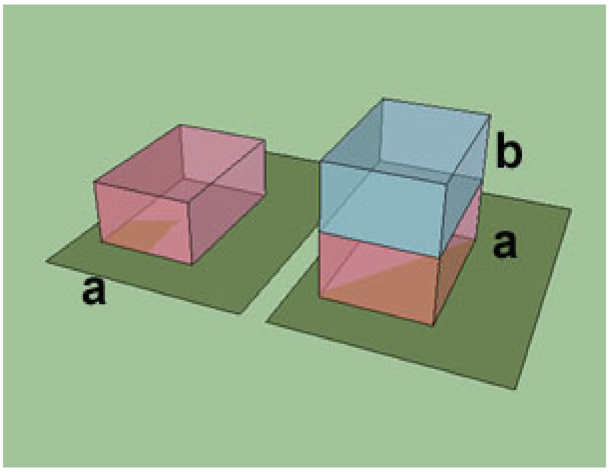

Fig. 8. Representation of relative volumes. For example: Volume 'a' is actually constructed, and the volume 'b' is the maximum envelope authorized by legislation. The constructed volume was used as the basis for a footprint, and the representation of 'b' denotes only the inventory of possibilities to increase volumetric occupation. The comparison between them is facilitated by relative representation. (PENSA, 2013).

3. PREPARING THE DATA TO THE ANALYSIS

We live in a moment of paradigm shifts in urban planning. We are turning from postmodernism to the parameterization of processes and values dictated by limits of what is acceptable according to sustainable values of society. In contemporary times, the new values have been representing and managing urban territories based on the principles of parameterization, interoperability among systems, Geodesign, strong investment in communication and dissemination in the network, community involvement (VGI - Volunteered Geographic Information), adjustment of standard procedures supported by legislation and policies to access information.

Just the ordinances of sectored and functional zoning spaces no longer meet the speed and dynamics of territorial transformation. Facing economic crises, urban planning has a new role, different from mere regulation of the private sector. This is the promotion of economic growth and corporate action to attract investments that invigorate the local economy by restructuring its production chain and redefining its economic role.

Upon the interest and need to make the city a site of economic production, planners seek to model a renewed image of the cities within the logic of interurban competition to attract investments. This has been termed by Harvey (1992) as "city marketing" and "entrepreneurship" of the cities. These urban transformations act as catalysts of complex transformations in the use and occupation of the territory. In this type of intervention, the association of public and private capital is common, with the interest from both parties.

Entrepreneurship occurs with private capital investments in public works, based upon interest in direct or indirect capital gain. Direct capital gain takes place in the form of increased commitments to constructive coefficients or occupation of areas through new real estate developments. Indirect capital gain occurs through recovering the area of intervention and ensuring real estate asset gain resulting from the surge of interest in the territory. But it's absolutely necessary to define limits of territorial occupation conditions, which means establishing urban parameters. In different scales, parameterization aims to define limiting conditions or envelopes.

The laws of urban land division and of occupation of the territory set up the tables to establish, by zone, types of occupation and define references for distances, occupancy rates and coefficients of occupation, among others. Building codes establish references of maximum dimensions for various building components to ensure minimum quality for the occupation. It is defined by community participation, being the planner the manager of actions and decoder of those interests.

The Master Plan and the laws of Land Use and Land Cover on Urban Occupation can no longer just set up the sectioning of activities in the city. It made necessary to propose instruments to evaluate different conformations of use and occupation, so that the requirements of sustainability and the capacity to receive transformations are met.

A major challenge of technology applied to the urban planning is the development of techniques and methodologies that are able to properly represent dynamic variables and create future scenarios of possible conformation of the city to define the best strategies and decision-making. It was inaugurated in the time of parameterization, with the new conditions for visualization, storing and sharing data, and modeling processes of urban and architectural landscapes, as advocated by Schumacher (2008). The author assigns great importance to these new values, stating that the parameterization is the new style after modernism, while postmodernism and deconstruction were only premature and transitory episodes.

What differentiates the postmodern era from what we term as parameterization time – until a new term comes up – is that proposed rules must not to be applied homogeneously to all components of an environment, not even within the same zoning. There are already legal and technical conditions for this new way to manage urban occupation.

From a technical point of view, the new challenges are based on configuring rules of behavior for variables and acceptable limits of alterations. Investments must be made in visualization tools, so that once rules are created, the non-expert user can perform simulations of changes in standards and observe the results on the landscape. This process will result in dynamic maps.

From a legal standpoint, it is acceptable and desirable that each territorial unit of occupation can receive its volume supported by calculations related to their own conditions and of its context. This means that even within one same zoning or settlement model, it is not mandatory that all lots observe the same coefficients and occupancy rates, the same heights. The potentials and constraints of each sector are observed. Each individual unit can have its parameters, within the principle of seeking a dynamic equilibrium of the whole.

The expected responsible and sustainable flexibility in territorial occupation, especially in occupation of lots, requires to be supported by the new simulation capabilities of the volumetric composition of the occupation, in a process defended by Moura (2012) as Parametric Modeling of Territorial Occupation or Parametric Modeling of Urban Landscape (MOURA et al., 2014, MOURA, 2015).

3.1 Methodology application example

It presents the main steps in a case study which covers from variable representation up to the simulation of urban landscapes, using visualization capacities and transformation from absolute into relative values.

3.1.1 Definition of main variables that characterize the territory

The first step is to choose the main variables that can tell about territory occupation and defines potentials and restrictions (Figure 9). They have to be chosen according to specialist's knowledge, but there are methods to review the list of variables based on their influence in the final result, as the Sensitivity Analysis to Suitability Evaluation (LIGMANN-ZIELINSKA & JANKOWSKI, 2014).

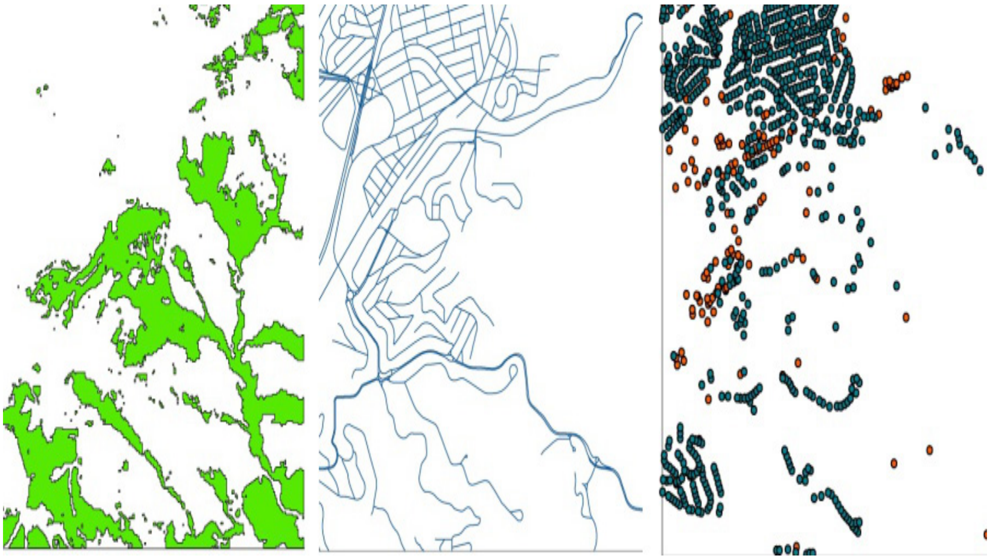

Fig. 9 - Individual variables: vegetation cover, roads, residential and commercial use.

3.1.2 Adjustments to measuring scales – from nominal, ordinal and of interval scales up to ratio scale

The variables must be transformed in raster representation as potential distribution of phenomenon, informing in each pixel the value of phenomenon distribution (Figure 10). That is a process to represent them in relative and not in absolute way.

3.1.3 Adjustments in the scales of values – normalization of values

The variables, in order to be combined, must be normalized (Figure 11). This is also a way to represent the variables as a set to be integrated, thinking in a relative way and not in the absolute way, because the same scale is applied to all the variables.

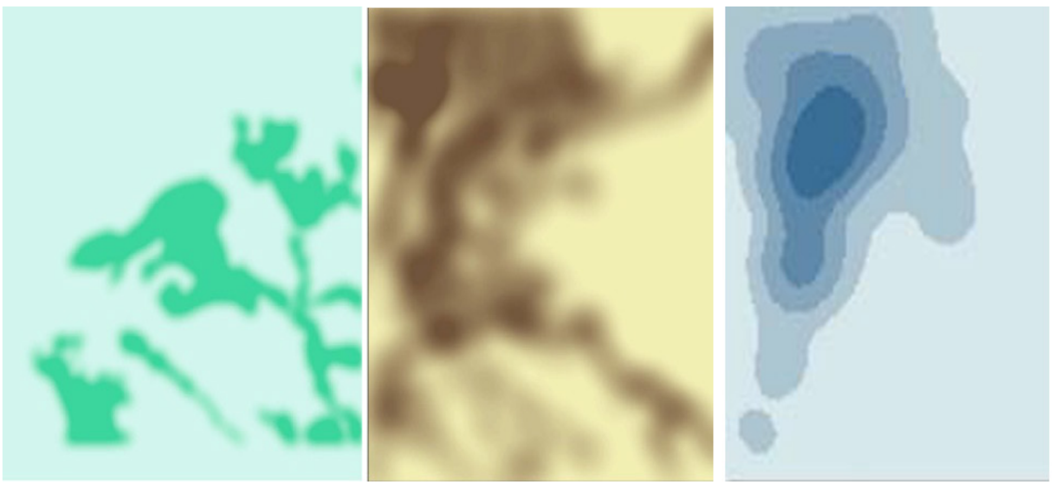

Fig. 10 - Variables adjusted to ratio scale of representation. The legend goes from high to low concentration of occurrence.

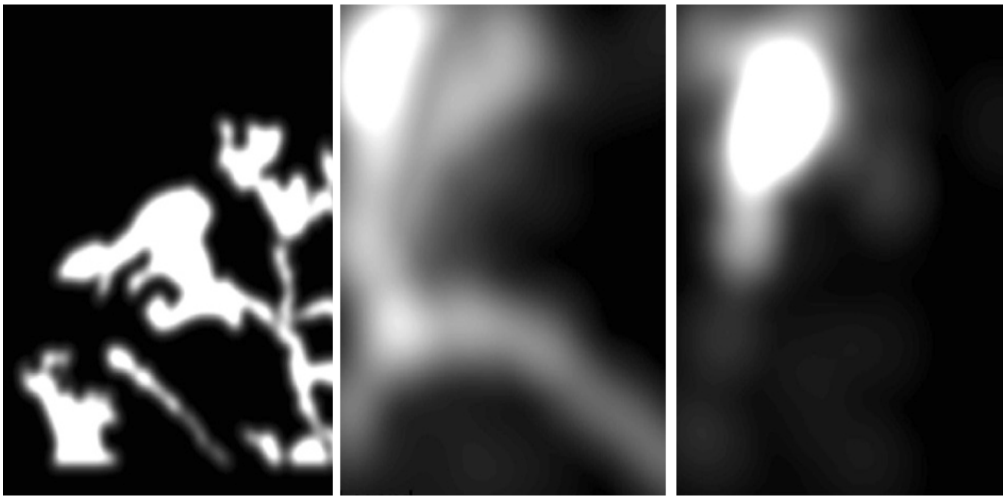

Fig. 11 - Normalization of variables. The legend goes from high to low concentration of occurrence.

3.1.4 Application of variables integration models – Multicriteria Analysis, and Analysis of levels of confidence in results (Suitability Analysis)

When variables are normalized to be used, they are combined in Multicriteria Analysis. This is a method that is quite used in spatial analysis, but the difference is to include the analysis of uncertainty in the process, informing the level of security the final result has been published (Figure 12). This new step is the 'Sensitivity Analysis to Suitability Evaluation' and is a way to present the result not in the absolute way, but in the relative way (LIGMANN-ZIELINSKA & JANKOWSKI, 2014).

3.1.5. Definition of potential areas and carrying capacity of the territory

The result is a more complex scenario of reality, presenting the scale of potential areas, but also the scale of uncertainty in the results. As already discussed, this is a way to avoid absolute positions and results. (Figure 13).

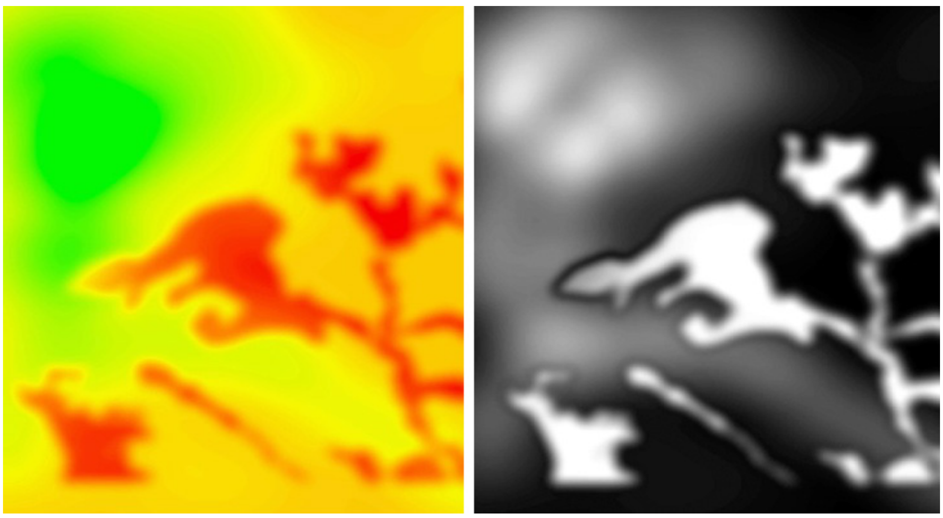

Fig. 12 - Multicriteria Analysis and Suitability Analysis. The legend goes from high to low concentration of occurrence.

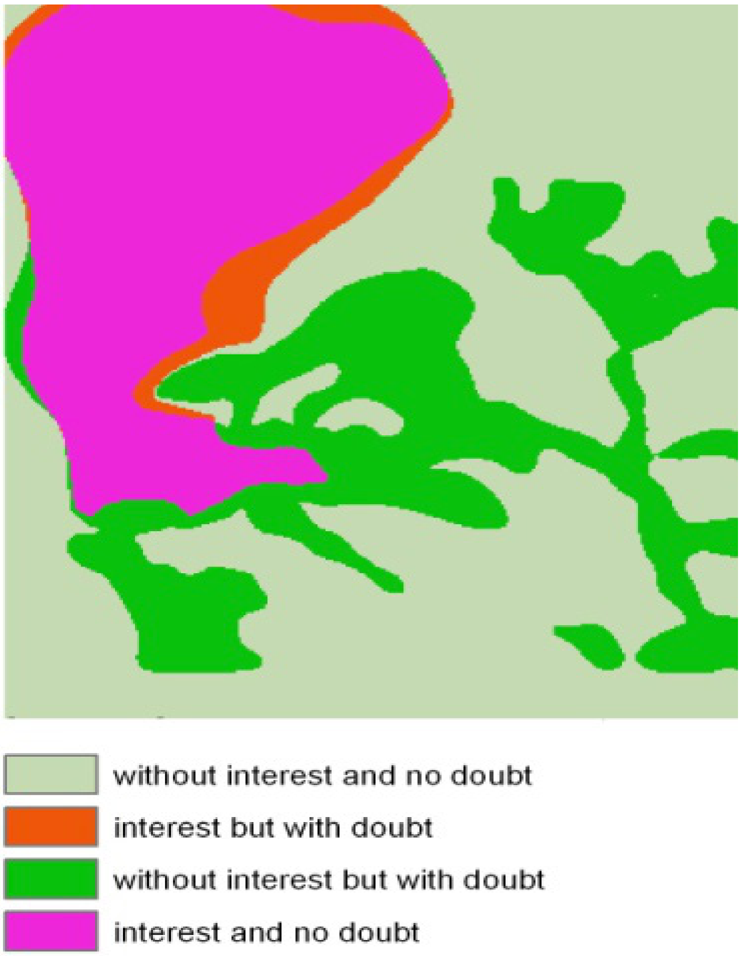

Fig.13 - Synthesis of potentiality on land use according to the combination of Multicriteria Analysis and Suitability Analysis.

3.1.6. Proposal of land use and simulation of possible new landscapes on urban territory

The proposal is to apply visualization tools to promote a first step: to allow the community´s interface and communication. (Figure 14).

With the right transformation of data and process based on changing from absolute do relative values, it is possible to make people understand characteristics, potentials and restrictions on the urban landscape and land use. Creating this interest in urban planning understanding, users can be involved and decide, together with the urban planner, acceptable limits to urban landscape transformations.

This means the use of parametric modeling to decode collective values, because it can be a dynamic process of suggesting and visualizing results, in each step of the process: definitions of potential areas (item “3.1.4” – Multicriteria Analysis to establish the area which can receive interventions and transformations), definitions of land use and land cover (item “3.1.6” – visual modeling of urban parameters) and, most importantly, construction of a take-part culture in decision-making processes.

The Laboratory of Geoprocessing at the Architecture School of UFMG has made significant investments in studies of Parametric Modeling of Territorial Occupation. The need arose from urban planning teaching and observing the great difficulty in understanding urban proposals, not only by the community, but, surprisingly, by experts – architects and urban planners, because not even specialists have the capacity to predict the future of a landscape defined by morphological parameters in Master Plans.

Brazil has the tradition of employing morphological criteria in urban planning as its main reference to manage urban occupation and in this it differs from other countries. We need, however, to consider a new morphology: not the modernist morphology that defines architectural design, but the new morphology that translates goals and collective values from society to model the common landscape.

In these studies of landscape simulation, with the challenge to change information from absolute into relative, to create a possibility of different users' understanding, the laboratory has invested in programming rules, which are scripts that structure definitions of morphological criteria (setbacks, floor area ratio, coefficients of utilization, volumetric possibilities, maximum heights, among others) (figure 15 and Figure 16). Using these rules, with variations in values of attributes, or possible adjustments in rules to meet specific needs of a zoning, any municipality can make clear its urban proposals (Figure 17). Among some recent articles on the development of rules, we mention Moura et al. (2014).

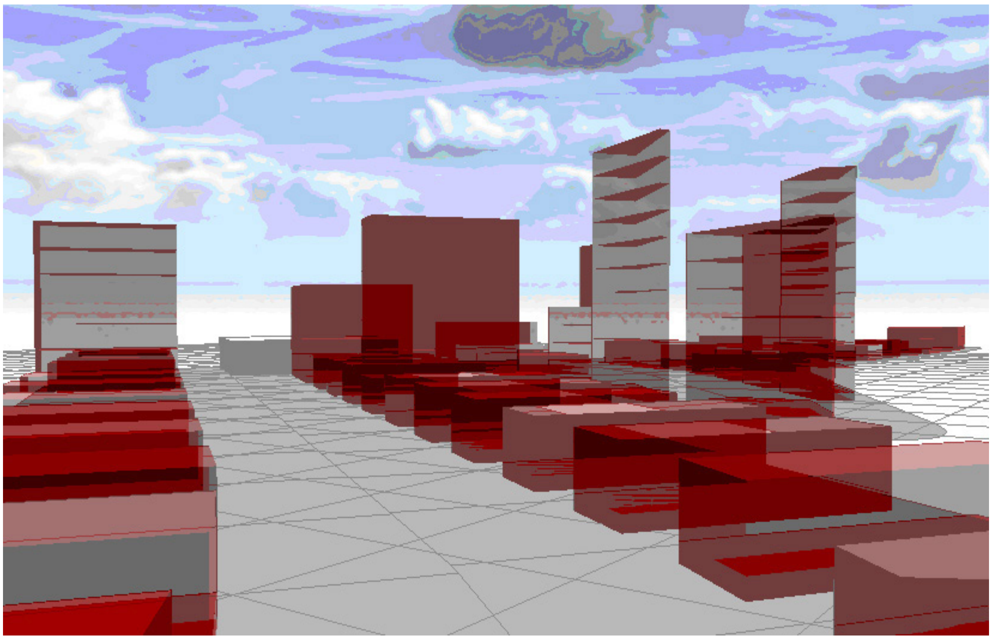

Fig. 14 - Parametric Modeling of Urban Landscape – simulating the use of the lots.

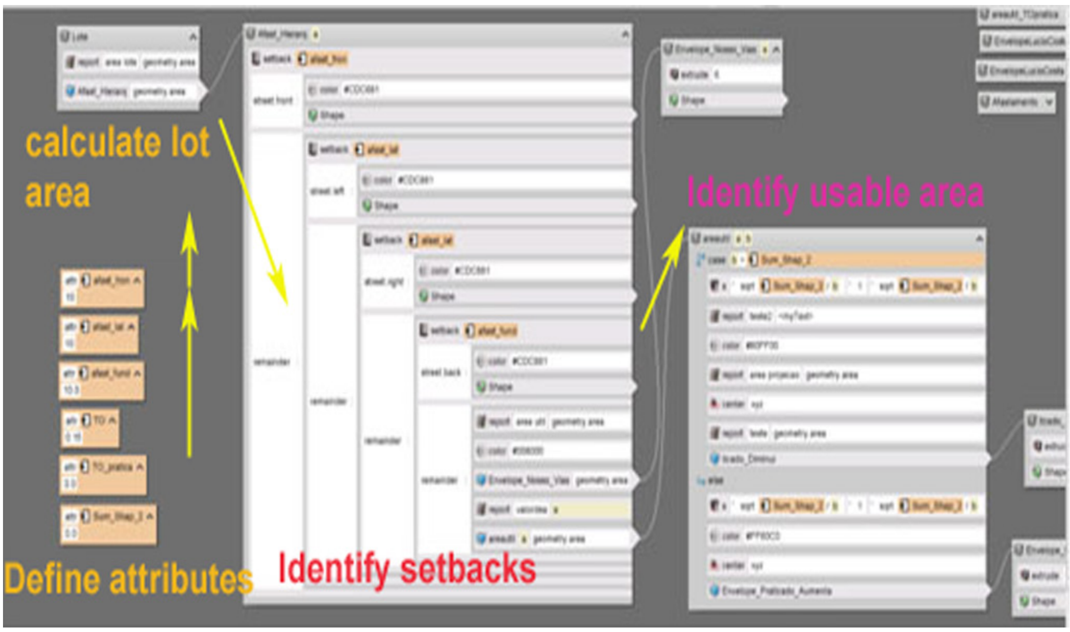

Fig. 15 – Definition of initial attributes.

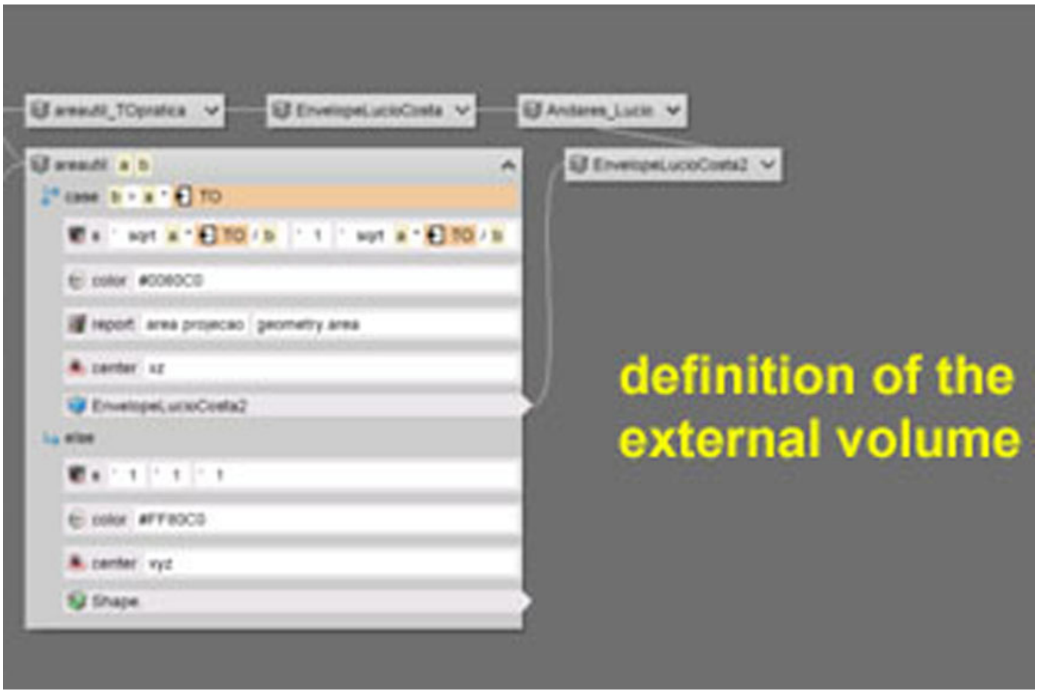

Fig. 16 – Rules of composing maximum envelopes.

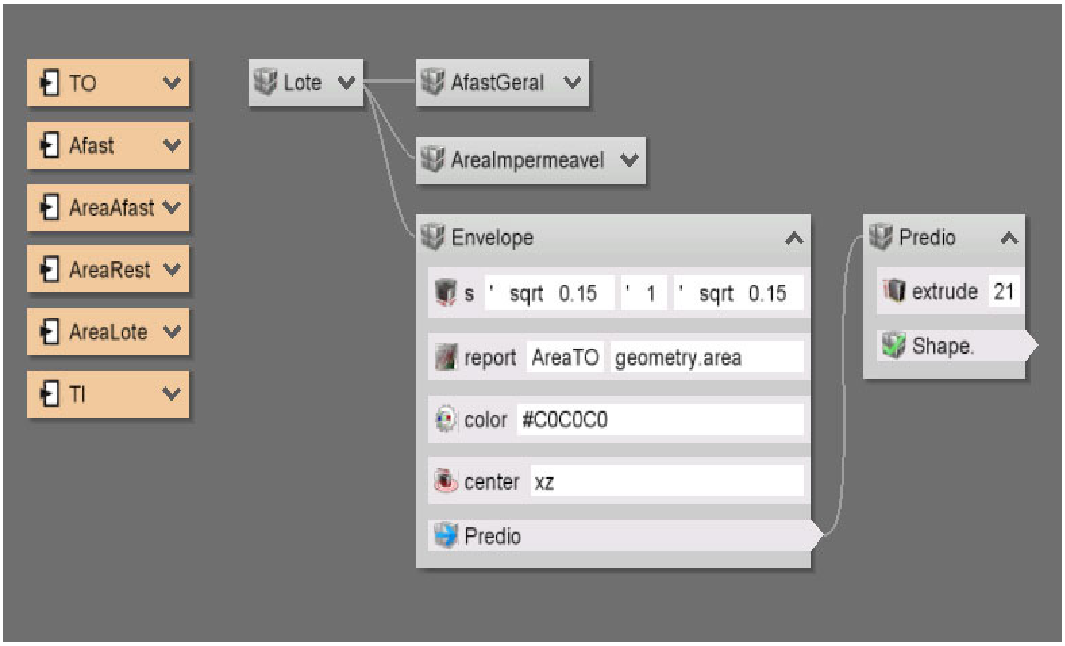

Fig 17 – Example of a rule constructed to simulate urban maximum envelopes.

In the presented example we simulate possible envelopes to the occupation of blocks in Brasília, as an academic essay to develop rules and make parameters of setbacks, rate of permeability, rate of occupation, coefficient of utilization and maximum heights understood. (Figure 18 up to Figure 21).

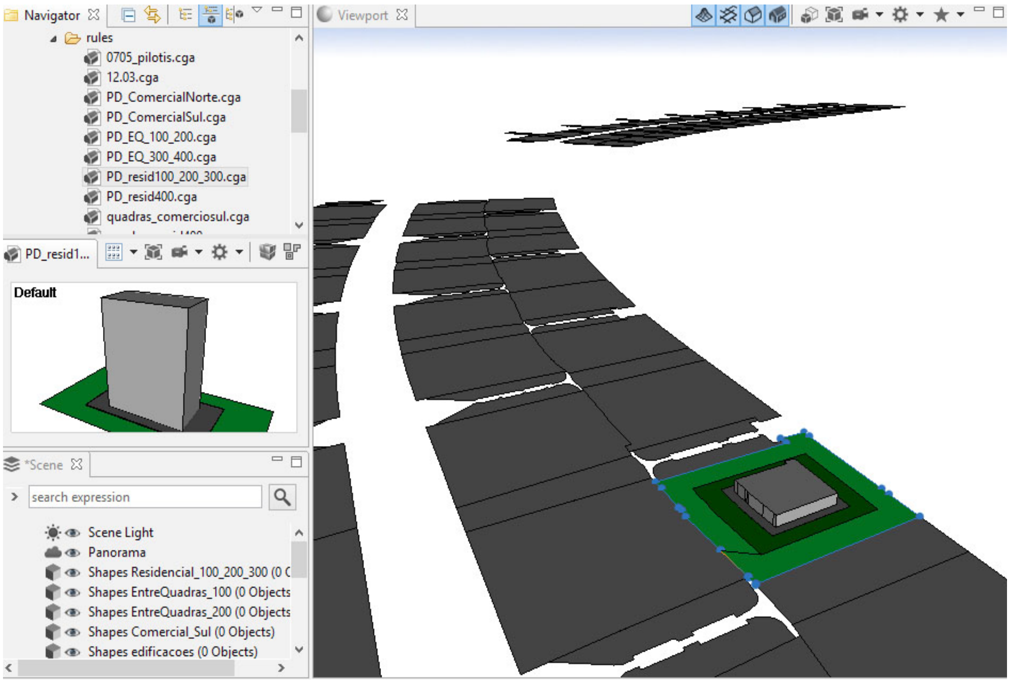

Fig 18 – Example of selection of one block, to which there is a rule structured to simulate results in urban parameters.

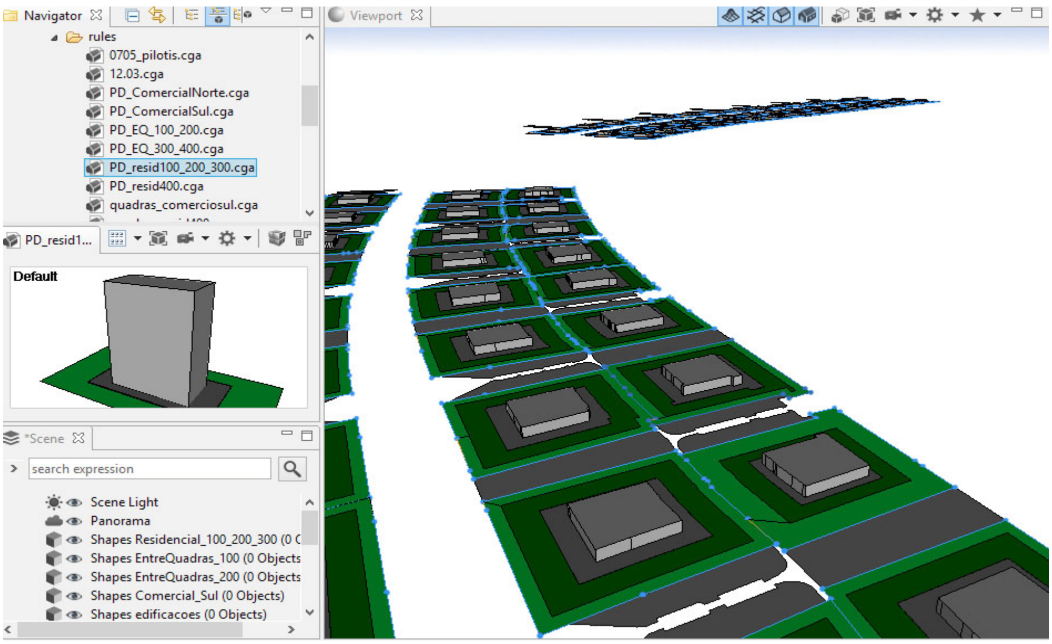

Fig 19 – Example of application of the rule to all the blocks that have the same conditions in urban parameters.

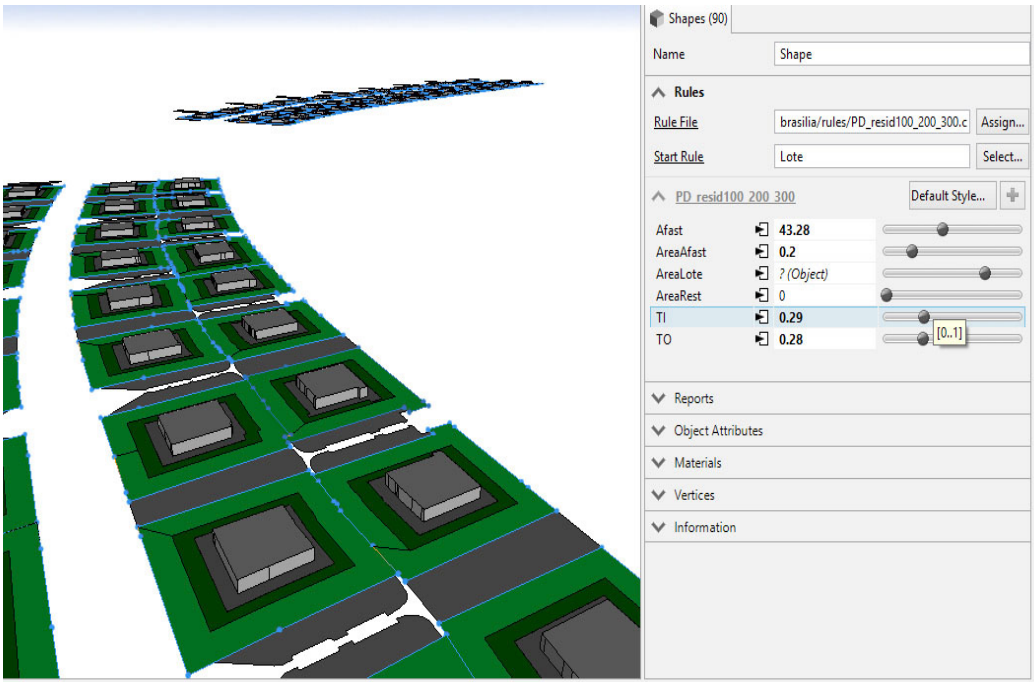

Fig. 20 – Simulation of changing attributes – changing rate of permeability area.

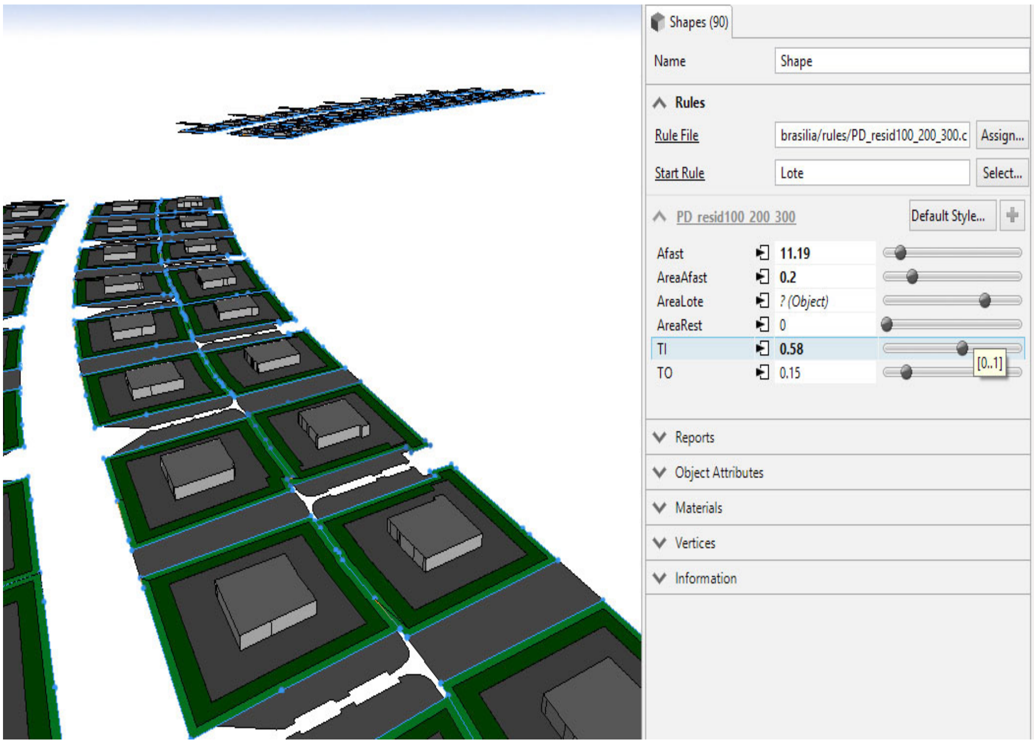

Fig. 21 – Simulation of changing attributes – changing setbacks.

4. CONCLUSIONS

We have been experiencing a significant change in the paradigm of urban design based on landscape requalification processes, urban surgeries guided by entrepreneurial processes, and more active city users' participation in defining their values and expectations. This brings about a commitment to use more effective forms of representation to the designs proposed for environmental planning and management.

The new procedures require studies of predictive intervention simulation in the urban landscape and significant collection of information to support decision-making. In this sense, geo-technologies, and in particular

Geographical Information Systems, occupy an increasingly prominent role in architectural and urban planning actions.

50 years ago, when Roger Tomlinson proposed the first Geographical Information System, developed for Canada, perhaps it was not possible to predict how the simple operation of automated maps analysis would become the reference for construction of new and complex methodologies for representation, characterization, analysis, proposition and simulation of landscape and urban design.

The methodological approach was quite simple: digitalizing of space into territorial units of analysis, variable selection on main components that could characterize the territory, proposition of forms of variables combination, all of which mean a systemic approach. In fact, the technique provided support to a way of thinking, and this was widely accepted, because the instruments presented facilitated methodological processes that were recognized under the logic in vogue.

Initial enchantment with the tools in and of themselves was natural, because human beings feel comfortable when they acknowledge in a new proposal a mirror to their way of thinking about the world. However, for some decades there was the question: new tools and old methods? The charming tools enabled urban designers to draw up new questions and acquire knowledge, or only made their work easier?

After the initial stage of enchantment, when the expressive production of beautiful thematic maps was enough, GIS was conducted to the construction of models, which are simplifications of reality, in order to give support to decision-making in territorial use and occupation.

There are still different situations and conditions of GIS application in the public sector and teaching institutions that prepare professionals for urban planning. There have been many efforts in legislation and standardization for the production and dissemination of territorial information, aiming to promote the creation of a significant data base that can support analysis, proposals and predictive studies in urban design. There is broad access to software, either free or those that require some investment. Digital communities are already articulated in order to facilitate quick exchanges of experiences. Then, what are the limitations and challenges to be faced?

Initially, it is important to underscore that tools, as charming as they might be, are just tools. They must be guided by a logical thinking that needs to be well structured by planning teams. Thus, everything begins with the clear definition of goals to be achieved. And to define these objectives it is necessary to recognize the demands of society and contemporary values.

Some GIS users invest much in the aesthetic appeal of visualizations, which enchants but can deceive. This is not the goal. The goal is to decode comprehension of spatial analysis, urban parameters and urban landscape transformation to the community. This does not mean hiding erroneous logic and/or invalid data, but quite the opposite: it means to make complex information clear. This means transforming the whole process's absolute representation into relative, avoiding the gap of communication that exists between planners and society. Parametric modeling of the territory is a way to get to a common decision, when the urban planner acts decoding collective values.

The user of GIS that can exploit the resources of geo-technology is the one that dominates, with knowledge, the proposition of the methodological approach using models of spatial analysis, models for the representation of propositions and the simulation of results. This user should be able to apply heuristic logic to learn from data and information built up by the system, adjust his methodology and models employed. The action of structuring processes and models, carrying out investments in methodologies of spatial analysis supported by geo-processing, has been called Geodesign by some authors.

The process of learning from the information must be supported by the awareness that models are simplifications of reality that meet certain objectives. This way, all models are partly questionable, but all models are useful. As each model is intended for one specific purpose in spatial analysis, it is important to promote interoperability between systems as this makes interface and data exchanges between applications easier. It is important to also promote interoperability between actions and actors, because the process must be understood as a systemic structure, and those changes at any stage can cause changes in the system as a whole.

The wide dissemination of territorial visualization tools in the worldwide network of computers enabled users to understand spatial data, because this expanded situation in which they consult maps and look at urban spaces. These same tools promote three-dimensional viewing, as well as the presentation of temporal changes and dynamic maps. These facilities established conditions for interest in geo-referenced information. It is argued, then, that the use of GIS can be an interface for communication between different actors of urban space planning and management, which brings with it the need for improvements in map viewing and urban design processes.

Another current issue is the changing role of the urban designer. The actions of authorial urban drawing, with decision-making responding for individual choices in creative processes, are increasingly restricted in face of contemporary values. The urban landscape is understood as a collective asset and for this reason should be tied to the values and interests which maximize a collective consensus. Thus, the designer must work within these limits defined by society as acceptable and as representative of their cultural values.

The contribution of the paper herein is also to question the way users have been applying GIS, because it is important to have control of what tools mean and promote. The tools have been creating users who have been working only for themselves and are not interested in heeding to community values or decoding common interests. The Parametric Modeling of Territory Occupation can be a way to promote interaction. The first step is investing in visualization, but it must be followed by the use of methodologies of receiving community opinions (VGI) to structure a process of work defining rules and actors (Geodesign), and to invest in models of Spatial Analysis and Simulations of urban planning and design.

It is important to propose research that is able to identify the core of collective values. Once these values are characterized, they turn into urban settings that will shape the urban landscape built. GIS is then used for Parametric Modeling of Territorial Occupation and of Urban Landscape.

ACKNOWLEDGEMENTS

We thank Belo Horizonte City Hall, Prodabel, for granting us access to their important database that has made our project possible.

We thank CNPq for their support of the “Parametric Modeling of Territorial Occupation: Proposition of new geotechnological resources for urban territory representation and planning”, Process 405664/2013-3, MCTI/CNPq/MEC/CAPES Nº 43/2013. Contribution to the project “Geodesign and Parametric Modeling of Territorial Occupation: new resources of geo-technologies to landscape management of Pampulha Region, Belo Horizonte”, with the support of CNPq – National Council for the Scientific and Technological Development. Call MCTI/CNPQ/MEC/CAPES Nº 22/2014, Process: 471089/2014-1, and to the Project “Programa Pesquisador Mineiro – PPM IX”, Process TEC – PPM – 00059-15.

The paper was originally presented at the XXVI Congresso Brasileiro de Cartografia, held in Gramado, 2014.

REFERENCES

ANDRIENKO, G., ANDRIENKO, N., JANKOWSKI, P., KEIM, D., KRAAK, M., MaCEACHREN, A., WROBELL, S. Geovisual analytics for spatial decision support: Setting the research agenda, In: **International Journal of Geographical Information Science**, 21 (8): 839-857, 2007.

BERTIN, J. **Sémiologie graphique: les diagrames, les réseaux, les cartes.** Paris, Mouton et Gauthiers-Villars, 1967. 432 p.

BONIN, S. **Initiation à la graphique.** Paris, Epi, 1975. 172 p.

CILLIERS, L., FLOWERDAY, S. Information security in a public safety, participatory crowdsourcing smart city project. London, **IEEE WorldCIS,** p. 36–41, 2014.

ECO, U. **Opera aperta.** Milano, Bompiani, 1962. 370 p.

GOODCHILD, M. F. **Citizens as sensors: the world of volunteered geography**. GeoJournal, 69 (4), p. 211–221, 2007.

HARRIS, B., BATTY, M. Locational models, geographical information and planning support systems. **Journal of Planning Education and Research,** 12, p. 84-98. 1993.

HARVEY, D. **Condição pós-moderna. Uma pesquisa sobre as origens da mudança cultural.** São Paulo, Edições Loyola, 1992. 349 p.

LIGMANN-ZIELINSKA, A., JANKOWSKI, P. Spatially-explicit integrated uncertainty and sensitivity analysis of criteria weights in multicriteria land suitability evaluation. **Environmental Modelling & Software**, DOI: 0.1016/j.envsoft.2014.03.007. 2014.

MacEACHREN A., GAHEGAN M., PIKE, W., BREWER, I., CAI, G., LENGERICH, E., HARDISTY, F. Geovisualisation for knowledge construction and decision-support. C**omputer Graphics & Applications,** 24(1), 13-17. 2004.

MANOVICH, L. Visualização de dados como uma nova abstração e anti-sublime. In: LEÃO, Lúcia (Org.). **Derivas: cartografias do ciberespaço.** São Paulo: Annablume, 2004. 225 p.

MCCORMICK B. H, De Fanti T. A., Brown M. D., Visualization in Scientific Computing. **Computer Graphics**, ACM Siggraph, 21(6), 1987. p. 4-7.

MILLER, W. R. **Introducing Geodesign: The Concept Director of GeoDesign Services**. Esri Press, 2012. 35 p.

MOURA, Ana Clara M. Geodesign in Parametric Modeling of urban landscape. **Cartography and Geographic Information Science**, v.42, p.323 - 332, 2015.

MOURA, A. C. M. Learning topics in urban planning at UFMG: geoprocessing to support analysis, planning and proposal of the urban landscape at neighborhood scale. Brasília, 5th Urbenviron - International Seminar on Environmental Planning and Management, Urban Responses for Climate Change. **Anais**, out. 2012. 15 p.

MOURA, A. C. M. Modelagem Paramétrica da ocupação urbana – do planejamento urbano autoral à decodificação de valores coletivos, de valores absolutos a relativos. XXVI Congresso Brasileiro de Cartografia. SBC. **Anais**, ago. 2014. 15 p.

MOURA, A. C. M., AMORIM, L. Simulação de transformação nas paisagens de mineração de ferro a céu aberto – metodologia de análise e simulação de gestão de paisagens. XIII Simpósio Brasileiro de Sensoriamento Remoto. INPE. **Anais,** abr. 2007, p. 4073-4080.

MOURA, A. C. M., RIBEIRO, S., CORREA, I., BRAGA, B. Parametric Modeling of Urban Landscape: Decoding the Brasilia of Lucio Costa from modernism to present days. Tema: **Journal of Land Use, Mobility and Environment. University of Naples Federico III.** Special Issue – Input 2014. Napoli, 2014. p. 695-708.

PENSA, S. Supporting Planning Processes by the Use of Dynamic Visualization**. International Seminar New tendencies on Geotechnologies to Urban Planning.** UFMG, Brazil, 2013. (comunicação oral).

SCHUMACHER**, P. Parametricism as Style - Parametricist Manifesto.** Dark Side Club 1, 11th Architecture Biennale, Venice, 2008. p.5.

SNYDER, K. Tools for Community Design and Decision Making. In.: GEERTMAN and STILLWELL (Eds), **Planning Support Systems in Practice,** Springer, 2102. p. 99-120.

STEINITZ, C. **A Framework For Geodesign: Changing Geography By Design.** Esri Press, Redlands. 2012. 208 p.