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Creating Collaborative Environments for the Development of Slum Upgrading and Illegal Settlement Regularization Plans in Brazil:

The Maria Tereza Neighborhood Case in Belo Horizonte

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ABSTRACT

This article describes how slum upgrading comprehensive plans and urban regularization plans are two planning tools which have been used by Brazilian municipalities to promote integrated interventions in slums and illegal settlements. Aimed at urban-environmental improvements, as well as land regularization and socio-economic community development, these plans have been, however, criticized for being too technical, time-consuming, expensive and top-down oriented, lacking sufficient participation and a strategic approach to achieve community consensus on priorities, under severe budget restrictions to face complex problems and fast changing realities. This article discusses the results of a workshop held in Belo Horizonte, Brazil aimed at developing a methodology for the Maria Tereza neighborhood plan, using Geodesign framework and geovisualization strategies to create a collaborative environment and enhance stakeholders' participation. The decision model achieved proved to be a promising support tool for more effective and inclusive neighborhood rehabilitation and land regularization planning policies.

KEYWORDS

Collaborative Planning, Geodesign, Geovisualization, Land Regularization, Neighborhood Rehabilitation, Slum Upgrading

INTRODUCTION

According to 2010 demographic census, the latest one conducted in Brazil, around 11.4 million people live in the 6.329 slums identified in 323 of the 5.567 existing municipalities in Brazil. This is how over 6% of the country's urban population have historically found a place in the city in the wake of insufficient social housing provision for those unable to access the formal real estate market and

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also not eligible for governmental housing programs (IBGE, 2010). Being almost totally oriented to housing ownership through subsidized credit, a massive housing deficit that is concentrated below poverty levels has never been seriously tackled by national public policies, which have benefited mostly middle-class segments. Thus, favelas and illegal settlements cannot be considered just a planning problem but a matter of shelter provision, an expression of the right to the city, a housing solution for many. Not to mention the fact that many of them are very old and consolidated settlements, being very well located within the urban structure, with good access to services and job opportunities.

However, the recognition of slums as a solution to be upgraded and not as an unsolvable problem to be removed and replaced by social housing projects in the remote outskirts of the city is somehow recent. The first efforts to protect these communities as part of the urban fabric and to keep them where they are date from the late 1980's (mostly from the 90's) when a specific zoning category was created to somehow reduce real estate pressures over them and to assign upgrading and regularization governmental programs and projects to those settlements. This began through local planning policies and experimental housing programs in municipalities under progressive administrations such as Recife and Belo Horizonte and only in 2001 it became a national directive under The City Statute (i.e. Federal Law 10,257) that, among other obligations to municipal master plans, established the definition of Special Social Interest Zones, and the development of urban improvements and land regularization policies for favelas and illegal subdivisions corresponding to these zones.

Consequently, specific planning tools have been designed for each of these two kinds of informal settlements, which can be defined as the following. A favela is characterized by an illegal occupation of someone else's vacant land (public or private), lacking, at the beginning, public essential services such as sewers, waste management, and public facilities. They usually show an organic morphology and densely built environment with little open space and green areas, being settled on improper sites, steep slopes, flood prone areas or even environmental protected areas where the formal real estate market cannot legally be present.

Illegal settlements may have very similar urban infrastructure and housing conditions as compared to slums, but they occupy land which has been previously divided into parcels (i.e. lots resulting from a given design), which have been sold in the informal market. This means families who occupy that land paid for it and feel they are owners, even though they don't have legal ownership documents. Being implemented without going through regular planning permit procedures, they do not follow official design criteria (e.g. minimum lot area, minimum street width, maximum slope and so on), they do not obey environmental constraints (e.g. steep slopes, forested areas, springs and water bodies, flood hazard areas, etc.), nor do they have the basic urban infrastructure that, according to Brazilian urban legislation, is the duty of real estate developers to implement.

Differences between these two typologies of illegal settlements are summarized by the following chart (Table 1) and can be clearly perceived by the compared images in Figure 1, which shows the urban morphology, the density patterns and the insertion of each of these settlements in the city context.

Belo Horizonte, with a population of over 2,500,000 inhabitants, has 186 favelas classified as ZEIS – Special Social Interest Zones and 29 illegal settlements classified by AEIS – Special Social Interest Areas, according to the local Master Plan and Zoning Ordinances (i.e. Lei municipal 7166, 1996, p. 3, 50 & Lei municipal 9959, 2010, p.18), which means they are supposed to stay where they are and be subjected to rehabilitation programs, following two main planning instruments: Specific Comprehensive Plans or PGE, as a short for Planos Globais Específicos (in Portuguese), and Urban Regularization Plans or PRU, (short for Planos de Regularização Urbanística). PGE and PRU are the current tools to plan integrated interventions and decide on priorities for these areas.

Figure 2 shows the location of these settlements within the municipal territory of Belo Horizonte. A clear concentration of irregular settlements (e.g. AEIS) in the far north and far south portions of the city can be noticed, which supports the characteristic of peripheral location of this type of occupation. On the other hand, favelas tend to have a more scattered distribution throughout the whole municipality, including a few larger ones in very central locations.

Table 1. Main features of precarious informal settlements by type: favelas and illegal settlements

	Favelas	Illegal Settlements
Origin	Occupation of public or private urban land, followed by informal market purchase and selling transactions.	Purchase transactions from informal real estate agents, without title deeds warranty.
Parcels (lots)	Irregular shapes and dimensions, resulting from the informal subdivision of the occupied area.	Regular dimensions arising from a previous design noncomplying to legal criteria and subdivision regulations.
Location	Central city, surrounding neighborhoods or peripheral areas.	Peripheral areas where land prices are low.
Design and infrastructure	Organic layout, predominance of pedestrian alleys and staircases. Absent or insufficient urban utilities, community facilities, services and open spaces.	Regular urban layout (lots and roads). Absent or insufficient urban utilities, community facilities, services and open spaces.
Housing conditions	Self and collaborative construction with poor materials (plastic canvas, tin, plywood), later evolving to unfinished masonry, unsafe locations (geologic and flood hazard areas), structural problems, unhealthy conditions.	Self and collaborative construction on unfinished masonry and low-quality materials. May also have structural problems but tend to have better healthy conditions

Source: Adapted and translated from Ministério das Cidades (2010, p. 20)

Figure 1. Compared satellite images of a favela and an illegal settlement in Belo Horizonte (Source: Retrieved from © 2017 Google)

Favela: Morro do Papagaio community, central city Belo Horizonte

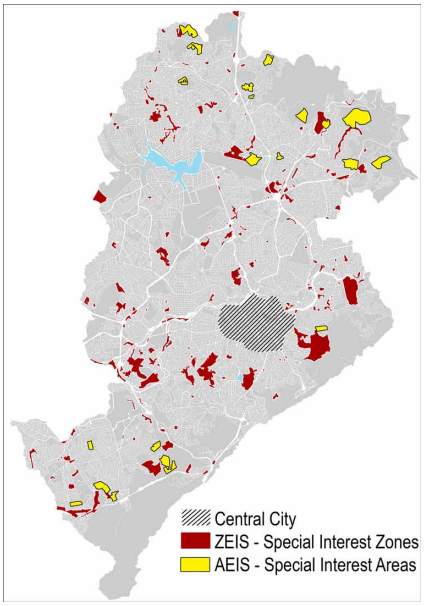
Irregular settlement: Maria Tereza neighbourhood, peripheral Belo Horizonte.

SLUM UPGRADING AND URBAN REGULARIZATION PLANS

Aiming at urban and environmental improvements such as sanitation infrastructure upgrading, geologic risks and flood hazard control, as well as legal ownership regularization and socioeconomic community development such as increasing jobs opportunities and income generation, PGE's have been developed for more than 30 years now by means of traditional thematic mapping method for both data collection/analysis and proposal strategies. It consists of three main steps as follows:

Step 1: Base map updating

Figure 2. Distribution of ZEIS (favelas) and AEIS (illegal settlements) in Belo Horizonte (Source: Belo Horizonte City Hall, 2016)



Step 2: Data collection, mapping and analysis
Step 3: Proposed interventions

A multidisciplinary team is involved in the process, including architects, urban planners, geographers, economists, engineers, geologists, lawyers, sociologists, social service and communication specialists, among others.

The first planning step is focused on the development of topographic and built structures and urban infrastructure base map. Usually developed from aerial photographs and topographic field surveys, it becomes the base map on which all collected data is registered. Community residents are usually involved in building up this base map, both as a way of accessing less evident areas and built structures as well as a capacity building strategy, aiming at future reading and understanding of the plans.

The second step refers to the development of the detailed inventory and analysis of the settlement. For this, field surveys and interviews with residents are carried out, as well as data collection from all available secondary sources. The diagnosis of the study area is built by relating sectorial data according to three integrating themes:

Iteration 1: Urban-environmental issues such as lack of basic sanitation, transportation, public spaces and community facilities.
Iteration 2: Socioeconomic and organizational community profile, including demographic data, labor opportunities, local leaderships and organizations.
Iteration 3: Legal land ownership status of the settlement and of its dwellers.

An important product of this second phase is the evaluation of different settlement areas, according to the complexity for regularization purposes due to both urban environmental conditions as well as legal status. This results in a map that shows areas which are considered “capable of regularization”, areas that depend on interventions to be regularized, classified as “capable of regularization under

conditions" and those where there is severe hazard or legal impediments to occupation, which are considered "not capable of regularization".

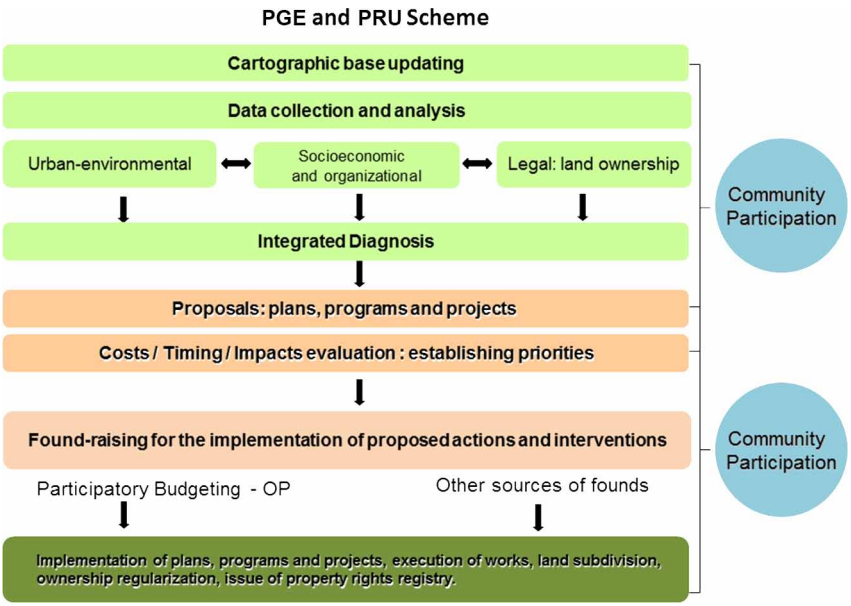
In the third and last step, interventions to achieve the settlement's urban and legal regularization are proposed and detailed. This process is based on the analysis of different future planning scenarios designed according to the level of physical change proposed for the settlements and their related impacts (Drumond, 2017). At this point, the community is called upon to participate and express their opinions on the presented scenarios. Discussions among consultants responsible for the plans, community representatives and public officials from the municipality lead to a chosen scenario. This is then developed as a final plan that comprises the detailed selected interventions, the priorities for implementation, time frames and budgets. This plan is then used to inform and guide public works in the community, being an important instrument in searching for financing, such as the participatory budget process as well as other funding sources.

Throughout this traditional planning process, citizens' participation occurs mainly through the so-called Reference Group (GR). This group of community residents is formed at the beginning of the planning process, and it is composed of formal and informal community leaders, members of local social entities (citizen associations, sports, cultural and religious groups) and also residents in general who are interested in participating. The GR is supposed to act as an intermediary body between planners and the community as a whole. They are responsible for sharing information with the other residents, making sure the main local demands are being covered by the plan and, mainly, for approving each of the planning phases (Drumond, 2017).

Figure 3 illustrates the sequence of the mentioned steps according to this traditional comprehensive planning methodology.

Within a period of more than 30 years, 68 PGE's have been accomplished, 05 are in progress and 01 is planned to begin. PRU, which are the plans designed for illegal settlements, started to be carried out only in 2016 as a result of a more recent policy following the same methodology applied for PGEs. There are seven PRU currently being developed and the Maria Tereza Neighborhood's is one of them.

Figure 3. PGE development steps according to the traditional comprehensive planning methodology (Source: Material from the authors, 2016)



Although this method has been successfully applied for many years, it has been strongly criticized for being too technical, too time consuming, expensive and top-down oriented. Among other authors, Conti (2004) and Bedê (2015) argue that one of the main shortcomings of PGE methodology is the lack of flexibility. Besides, the three stages of the plan are completely independent, and there is no feedback among them, which makes it difficult to update it during the planning process.

It is worth mentioning that when the municipality launches a PGE or a PRU, a large expectation is generated in the community regarding infrastructure improvements, but also and most importantly, with a view to obtaining land tenure documents. This ends up by attracting more people to live in those settlements, encouraging the densification of built areas and growth through the occupation of other vacant spaces in surroundings areas. Since the planning process lasts about three to five years, informal real estate speculation within the community often materializes before the interventions take place. According to Conti (2004), the lack of efficient strategies to stop densification and growth, as well as methods to update plans, as the dynamics of the territory changes is what makes PGE become obsolete so quickly. Bedê (2015) highlights the lack of federal funding as an obstacle for the fast implementation of those plans. In addition, this demotivates community participation and leads to the discontinuity of the planning process.

Other authors (Silva, 2013; Mello, 2009) also point out that the first two steps of the planning process take too much time and money, since they require very broad surveys and an extremely comprehensive set of data, some of which are not necessary to support the proposals. This way, they argue that PGE's have become a collection of extensive analytical reports, followed by intervention projects, which are very superficial and poorly developed. Inventory and diagnosis phases drain most resources and time, leading to a shortage of time and money for the proposals per se, which is frustrating for both planners and the community.

Besides, although there is a great effort in the analysis of the territory, the cartographic bases are produced individually in CAD platform, which makes it difficult to merge all the information on a single geo-referenced base that would allow for synthesis maps and a comprehensive view of the area's problems and potentialities (Mello, 2009).

With regards to the participation of citizens, it is widely perceived that there is a great difficulty for engaging the Reference Group in a continuous basis as a voluntary activity in such a long process (Silva, 2013). Since participatory events are not permanent and the interval between meetings is usually long, it is common for the group of residents to lose interest in the plans and stop participating. There is no guarantee the GR communicates well and broadly with the whole community, which also generates misunderstandings and false expectations towards the content of the plans.

Additionally, the very complex subjects and the technical language that characterizes the content of these plans require a decoding ability that community members do not have (Nascimento, 2011), especially when taken into account the low level of education of slums and informal settlements residents as well as the social vulnerability situation in which they live.

CITIZEN'S PARTICIPATION, GEOVISUALIZATION AND GEODESIGN STRATEGIES

Within the context of information technology development, new instruments for spatial analysis, evaluation and representation have become essential tools for territorial planning and management. Among examples of new technologies applied to cartography, GIS mapping and geovisualization stand out for their availability, usability and accessibility, resulting in an important breakthrough for information sharing in planning processes (Masala & Pensa, 2016).

Representing a given territory is the first step to get to know it (Moura, Marino, Ballal, Ribeiro & Motta, 2016). As regards urban and regional planning, geovisualization can also be understood as a tool to broaden the possibilities of community participation in decision-making processes. As a means to enhance spatial understanding, it allows for higher alignment and leverage of information

among different stakeholders within a participatory planning process. It is, then, essential to provide voice to those so far excluded from planning decisions due to the absence of technical knowledge or for not feeling able to contribute.

Van Den Brink and Dane (2007) proposed a synthesis comparing different typologies of participation based on the works of Arnstein (1969), Edelenbos and Monnikhof (1998) and a few governmental guidelines for participatory planning, including the European Commission's (2002). They range from manipulative passive processes to more interactive and collaborative planning experiences, depending on the degree of power distribution and stakeholders' involvement in the decision-making process.

Different levels of participation consequently relate to different requirements for the use of digital media as a planning support tool. Streich (2004) proposed three increasing degrees, from information supply and consultation, somehow applied in Brazil in participatory local Master Plans and public hearings (Santos, 2011), to active participation, involving co-producing and co-deciding planning strategies which also relates to a growing number of actors eager to influence the contents of plans.

The prevailing methods in participatory planning in Brazil follow two basic steps. The first consists of technical inventories and analysis made by specialists resulting in comprehensive reports that often contain thematic maps. The second relates to the discussion of the technical understanding of the study area's main issues with community members through participatory workshops and public hearings, with the help of the cartographic material which has been produced (Ministério das Cidades, 2004). The discussion process, however, is often deficient and does not achieve expected goals as far as effectively involving and communicating with the general public.

Peet and Leach (2000) have already highlighted the growing reticence among citizens and NGOs to use institutional participatory instruments also due to bottlenecks arising from the use of technical language and sectorial approaches to describe a growing complexity of planning issues. Masala, Pensa and Lami (2013) emphasize the use of geovisualization in order to stimulate communication and discussion among actors involved in the decision-making process and as a means for allowing the planning process to be more effective towards the promotion of more sustainable urban development policies.

Aiming at more inclusive and interactive participatory processes, geo-visualization approaches seem to increase opportunities for citizen participation in spatial planning as an essential tool to create collaborative environments for co-producing planning strategies and decision-making processes, which are also the main goals of Geodesign.

According to Steinitz (2012) Geodesign is a methodology that provides a design framework and supporting technology to leverage geographic information, resulting in designs that more closely follow natural systems. It is, in fact, a portmanteau word to describe a planning method based on communication strategies aimed at sharing knowledge, assumptions and language to achieve an effective collaborative decision-making process.

In theory, the concept of Geodesign reflects the idea that a good territorial design depends on the knowledge of existing conditions (i.e. constraints and possibilities) and the ability to work with them. Thusly, the concept of Geodesign is mostly related to the contextualization of proposals in the existing landscape. Miller (2012) argues that the essential aspect of this definition is the idea that design occurs within the context of geographic space as opposed to a conceptual abstract handmade space on pencil and paper or even digitally with the use of computer-aided design.

The increasing use of digital technologies, especially Geographic Information Systems (GIS), has made the concept of Geodesign applicable in more complex situations and in larger planning units (Zyngier, Moura, Araújo & Carsalade, 2016). However, the simple data collection and maps overlay do not mean a significant advance in the design methods. This way, Steintz (2012) has been proposing a complete methodological scheme, including conceptual framework, design strategies, and procedural techniques. As opposed to returning to the old mapping overlay techniques, it emerges as a new field of research which integrates and adapt the GIS concept to the design platforms (Batty, 2013).

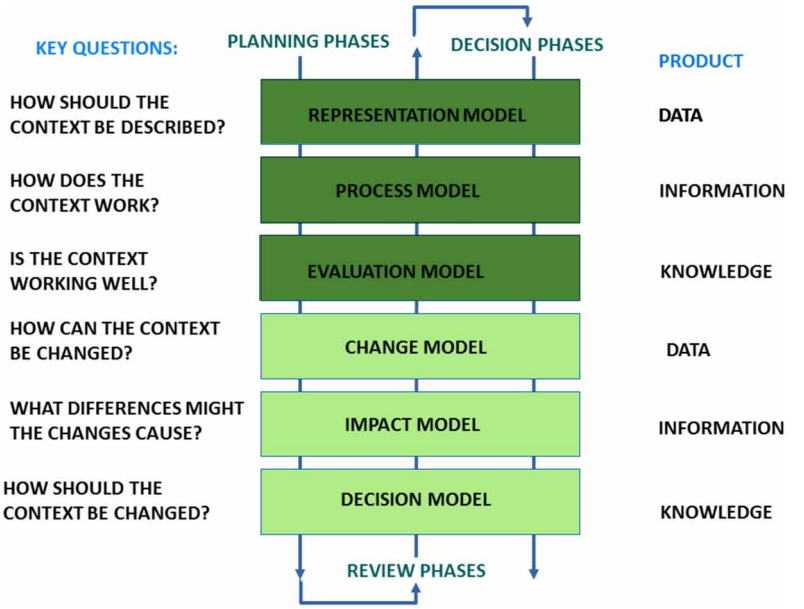
Within the Geodesign framework (Steinitz, 2012), design professionals and geographic scientists, information technicians and local stakeholders (people of the place) are supposed to work together to answer key questions about the problem area, integrating data, knowledge and values through planning phases and related models. It suggests the use of six models linked to six key questions whose answers are supposed to describe the whole planning process, as seen below:

- **Representation Models:** How should the context be described?
- **Process Models:** How does the context operate?
- **Evaluation Models:** Is the current context working well?
- **Change Models:** How might the context be altered?
- **Impact Models:** What differences might the alterations cause?
- **Decision Models:** Should the context be changed?

The first three models comprise the evaluation process, looking at existing conditions within a geographic context. The second three models comprise the intervention process, looking at how that context might be changed, the potential consequences of those changes, and whether the context should be changed. The author advocates that these questions have to be analyzed and answered three times, according to three different iterations each. The first iteration is aimed at defining the planning goals and objectives to the study area. It is supposed to answer the question "Why study this area?" The second iteration has the function of guiding the planning methods to be used. The question to be answered at this point is "How this area should be studied?" Finally, the third round is aimed at the implementation of the chosen scenario, and it involves strategies, policies, plans and projects. It is supposed to answer the questions on "what, where and when interventions in this area"? Figure 4 presents the methodological structure proposed.

According to this method, the decision model drives the whole process, so that, regardless the shortage of data and time, a proposed intervention with a reasonable degree of consensus is supposed to come out at the end of the line.

Figure 4. Geodesign framework steps for a collaborative planning decision-making process (Source: Adapted from Steintz, 2012)



The achievement of an informed decision through collaboration depends, however, on collective knowledge building and for that purpose many different tools and methods have been developed as Planning Support Systems (PSS), in which the use of spatial data visualization has played an important role and produced promising benefits to participatory planning.

THE MARIA TEREZA GEODESIGN WORKSHOP

The Maria Tereza neighborhood is a fast-growing new settlement located in the northern urban expansion region of Belo Horizonte. It is only ten years old, and it had a population of 373 inhabitants in 2010, according to the latest census data (IBGE, 2010), which is now assumed to have almost doubled. Its main problems are its isolation with regards to more developed areas, lack of basic infrastructure and public services and occupation of steep slopes and hazard areas.

In September 2016 a three-day planning workshop was conducted by faculty members from UFMG GIS Lab, at the Belo Horizonte City Hall, using the Geodesign framework and geovisualization tools to create a collaborative environment and enhance stakeholders' participation for the development of a PRU for the Maria Tereza neighborhood.

Existing inventory data and variables on the study area had been previously combined to produce a set of thematic maps within the Geodesign framework context. They comprised the representation model that describes the area's context and the process model that shows how it is currently working. The two-combined resulted in evaluation models, named "systems", which analyze if the area is working well. They included hazard and environmentally sensitive areas, sanitary vulnerability, housing conditions, densification possibilities, urban integration and urbanity based on preconditions to form and access centralities.

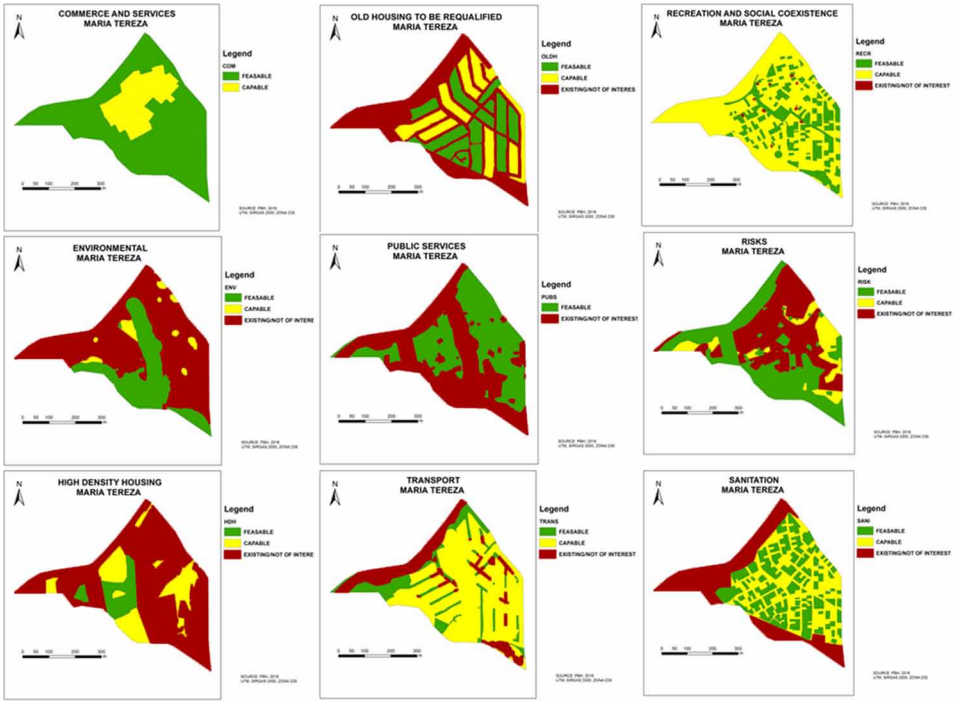
These systems were also classified in advance by the workshop coordination team under a methodological supervision. Also, an ICT researcher, responsible for conceiving the Geodesignhub platform[1] followed this process and attended the workshop through videoconference devices. Each map received a classification that indicates feasible areas for intervention (green light), areas capable of intervention subjected to specific conditions (yellow light) and areas with no need of intervention (red light), according the system theme. These maps functioned as evaluation models (Figure 5).

The 60 participants were divided into two main teams that were assigned to work separately in the first and second day of the workshop. Both teams were formed by faculty members, graduate students and public officials from different local authorities, including roads and transportation, green areas, social housing, water and sewers, social assistance, land use planning and urban control departments. Each team was then divided into six interest groups, according to six main focus goals and planning objectives to be pursued. These were socioeconomic development; sociability and urban design, related to public spaces and amenities; existing housing improvement and new housing production; land ownership and regularization; environmental and landscape concerns and mobility. This last topic involved connections within the neighborhood and from the neighborhood to the surrounding areas and to the city, as a whole.

Each group was then stimulated to simulate an interest group and make proposals in terms of projects and policies that were translated into diagrams resulting from points, lines and polygons that were drawn on screen covering the areas where they were supposed to take place. The use of the Geodesignhub platform allowed for simultaneous visualization and assessment of the proposed diagrams (i.e. change models) by all groups. At this point, impact models were built from a compatible interest matrix so that the groups could see the outputs of their decision in each system and evaluate the emergence of conflicts caused by each proposal.

As a second moment in the workshop, participants were regrouped into three teams, and each one was responsible for the selection of the most adequate diagrams designed on the previous step, joining them together, and building up a complete master plan for the Maria Teresa Settlement. Simultaneously, Geodesignhub provided the calculation of costs, assessment of impacts and conflicts

Figure 5. Systems and color codes used in the workshop (Source: Material from the authors, 2016)



of the final design, helping in the decision-making process. The participants also used a 3D digital model of the study area to support mental mapping processes.

As a final activity, the three different master plans were compared, and the participants were encouraged to discuss the solutions, merge the proposals and create a single plan. The same procedure was repeated on the following day of the workshop with a second group of 30 participants that also came up with another single plan as a result of a collaborative decision-making process under the same methodology. The comparison of both results showed that although there was a high degree of consensus among the diagrams proposed by the two groups, priorities and final results varied, according to each group's decision model. Figure 6 shows the level of importance given to each "system" by each group. It can be noticed, for example that, although transportation was considered a prime concern by both groups, there are relevant discrepancies with regards to how other systems like environmental protection, hazard control and high-density housing was weighted.

Such choices have an important influence on the choice of which diagrams will-appear on the final plans that ended up having similar but different results. The workshop outcomes highlight the fact that, even though Geodesign improves disciplinary interaction and knowledge exchange, it does not solve conflicts of values, interests and motivations, which continue to be a matter of negotiation and compromise. As a matter of fact, increased previous knowledge about the study area, and more time for discussion were two very important demands pointed out by the workshop participants that could also help maximize the opportunities for reaching consensus.

At the end of that session, all 60 participants were asked to fill in a questionnaire for a final qualitative evaluation of the workshop. There were open questions on their general perception on the applicability of the Geodesign framework for PGE and PRU development purposes as well as on the positive and negative aspects of using Geodesign in comparison to traditional analogic comprehensive planning methods. Answers to these two sets of questions were summarized in the following tables.

Figure 6. Definition of system weights by workshop participants (Source: Material from the authors, 2016)

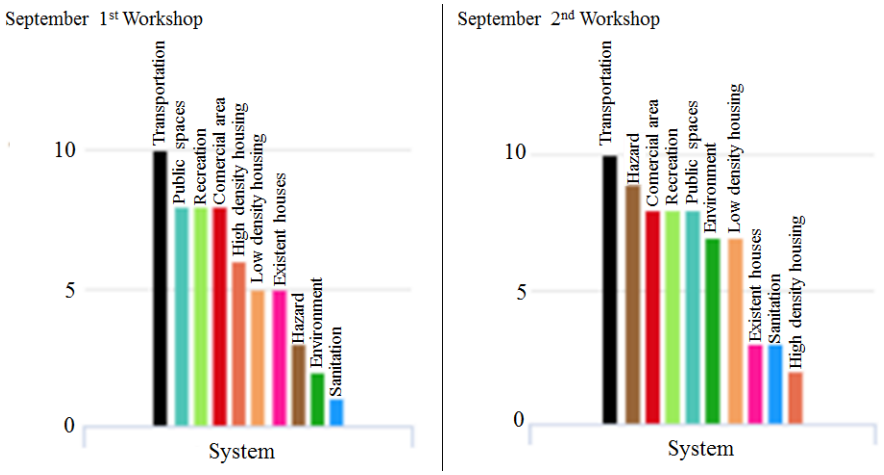


Table 2 shows that, as a general impression, the majority of participants see advantages in using the Geodesign framework as a planning support tool for its transparency, flexibility and economy of time and resources. There was also a significant number of respondents (40%) that relate the method to the early phases of a plan, when a structure base map is to be agreed upon, before it can be developed as a technically defensible final plan. Although many recognize the method's potential to make conflicts clear and promote objective compromises and consensus, there is a significant

Table 2. General perception of workshop participants about the use of the Geodesign framework as a planning support system for PGE and PRU development

Statements	Number of Responses
Can provide a structure base for collective planning inputs but needs a following technical development to become a final plan.	24
May face cognitive, graphic and digital divide, especially with uneducated, low income and elderly population.	12
Makes it easier to establish community priorities and to guide public policy allocation to the study area.	12
Turns conflicts evident and help support opinion forming and decision making.	9
Allows for quick spatial location of proposals and interventions.	8
Allows for simultaneous integration of sectorial proposals, coming from different fields of knowledge.	8
The Geodesign method should be tested on a real plan, involving local stakeholders.	6
Very useful to speed up the diagnosis process.	6
Will reduce costs and optimize results.	6
Improves comparative conditions to justify project financing and decisions on budget allocation	2
Makes it possible the creating of new proposals based on an 'expeditious' diagnosis.	1
Geodesign is not an adequate method for PGE and PRU development.	1

Source: Material from the authors, 2016.

perception of difficulties low-income communities may face with the use of information technology devices (25% of the respondents).

Responses to the question about the positive and negative aspects related to the use of Geodesign compared to traditional comprehensive planning methods were then grouped as shown in Figures 7 and 8. Most mentions to positive aspects were related to the integration of different professional perspectives and the progressive consensus building process provided by the method, followed by the optimization of time and costs.

Figure 7. Main positive aspects pointed out by workshop participants about the use of Geodesign as a planning support framework for PGE and PRU development (Source: Material from the authors, 2016)

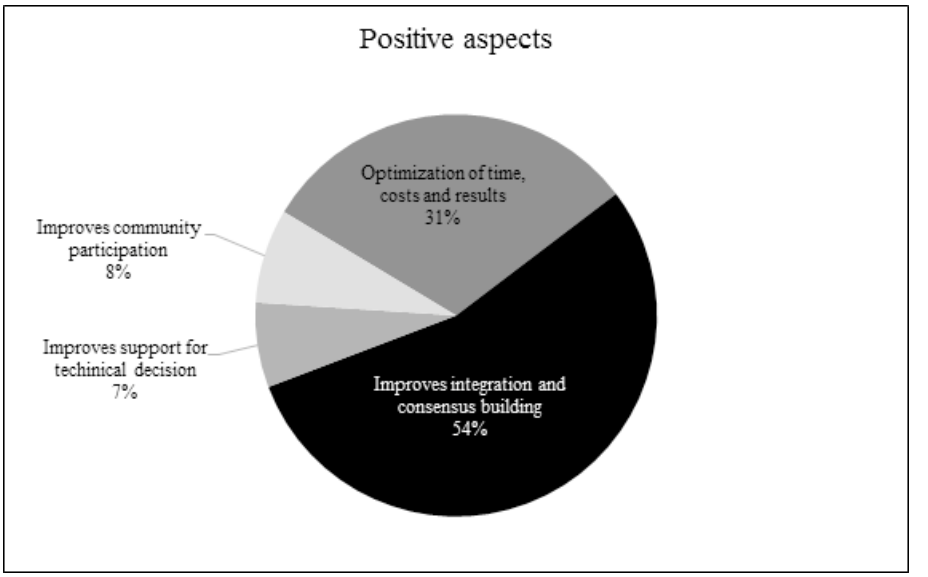
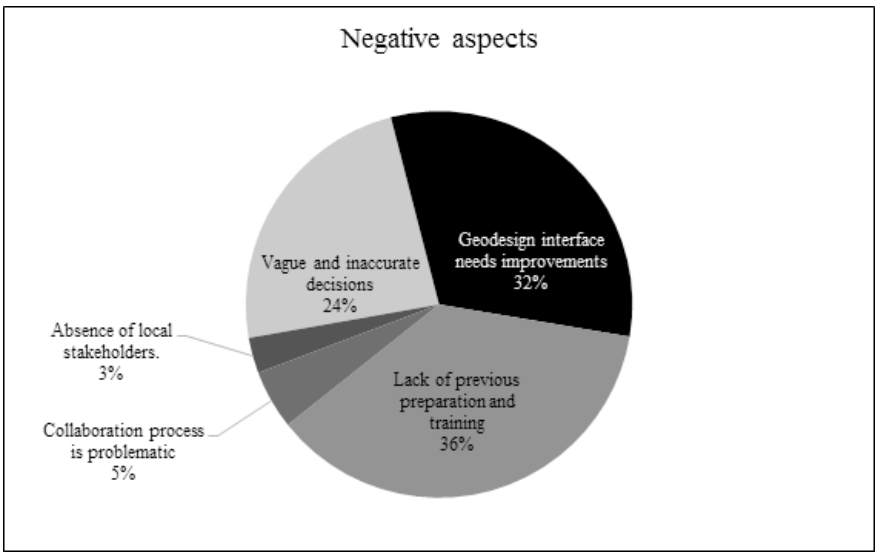


Figure 8. Main negative aspects pointed out by workshop participants about the use of Geodesign as a planning support framework for PGE and PRU development (Source: Material from the authors, 2016)



With regards to the negative aspects, the responses showed that the main concerns about the use of the Geodesign framework are related to the lack of previous knowledge about the study area, the need for more time for preparing and discussing the proposals and difficulties in dealing with the Geodesignhub platform which was considered not sufficiently friendly by 26% of the participants (see Graph 2).

Finally, participants were invited to evaluate the results of the workshop as far as addressing the study area's main planning issues and to make suggestions on the necessary improvements to the method. A ranking of the responses is presented in Tables 3 and 4.

Responses in Table 3 attest to the success of the workshop in introducing the Geodesign framework as a tool to promote participatory planning within a context of little data and money, in a short period

Table 3. Workshop evaluations as far as far as addressing Maria Tereza Neighborhood's main planning issues

Answers	N. People
The spatial allocation of proposals and development of comprehensive scenarios was reached with little data and within a short period of time.	17
Integrated proposals, coming from different planning sectors and fields of knowledge.	17
Optimization of knowledge and resources.	15
Fast consensus on collective proposal and priorities based on successive approximations	12
High consistence among inventory, diagnosis and proposals.	6
Clear picture of conflicts underlying the decision-making process.	5
Fast allocation of basic structure for the plan: main accesses, centralities, community facilities, open spaces and environmental protection areas.	5
Provided visualization of targets, costs and impacts of main proposals.	5
Resulted in policies to keep the families in the area and to promote the resettlements.	1
Encouraged objective discussions based on the same methods and criteria.	1

Source: Material from the authors, 2016.

Table 4. Main aspects to be improved for a future use of Geodesign framework for PGE and PRU development

Suggestions	Number of Responses
Improve interface features: Portuguese version, drawing process, diagram accuracy, system visualization.	15
Provide more information on the study area, mainly social data.	10
Involve community members and local stakeholders (people from the focused place).	8
Leave more time for group discussions.	7
Involve participants in previous choice of variables and definition of systems and targets.	7
Provide better information on implementation costs and targets.	4
Provide complementary information on surrounding areas, plans and projects.	4
Qualify and detail proposals, including legal, technical and economic feasibility.	4
Consider non-spatially allocated proposals.	3
Improve and dedicate more time for training strategies.	2

Source: Material from the authors, 2016.

of time. Even though many improvements to the interface and to the workshop dynamics were considered necessary, as shown on Table 4, the method proved to be a promising support planning tool for more effective and inclusive future PGE and PRU development.

As a result of this workshop, a decision by the local government to go forward testing the use of Geodesign as a planning tool was made. The method is currently being used at the Dandara Community Urban Regularization Plan, a recently recognized squatter settlement that houses around 2,000 dwellers in an environmentally sensitive area on the outskirts of Belo Horizonte. It-has been the first Geodesign planning experiment in Belo Horizonte involving community residents and other local stakeholders. More time has been assigned for training community residents on the methodology, also involving youngsters who are usually more receptive to the use of information technologies. Improvements to the Geodesign interface have also been tested, so that future evaluation of results will soon be made possible.

CONCLUSION

The use of the Geodesign Framework allowed for an interactive participatory process involving the simultaneous evaluation of alternative actions as well as a series of possible changes that may be proposed by community members to match local demands and expectations as well as follow up by local social organization groups and leaderships.

Even though conceived as an academic and technical experiment, this workshop involved public officials from different sectorial planning departments, faculty members and private consultants who are usually in charge of developing these plans. The methodology proved to be very effective as an integration tool, enhancing group work and interdisciplinary practice (Moura, Marino, Ballal, Ribeiro & Motta, 2016).

Public participation in PGE and PRU development may be improved in all phases but especially at the decision-making process when priorities are supposed to be defined. This planning stage is strongly dependent on community support for fund raising, implementation and maintenance, not to mention the land regularization component that usually has a very important social, political and compromising component.

As highlighted by Fonseca (2016), the Geodesign methodological framework relates to an open system that is subject to data inputs and outputs throughout the whole process. This allows for changes in both physical designs of proposals as well as redefinition of goals and objectives, which makes the planning process very dynamic.

The method also allows for a systemic and critical assessment of each planning step, integrating inventory, diagnoses and proposal phases as open systems that may receive feedbacks and alter the initial concepts of a given intervention at any moment (Fonseca, 2016). In this manner, planners and other stakeholders get involved in the planning process in a more balanced way, even though Steinitz (2012) highlights the need for a more intense participation of planners in the change models generated from the fourth question on.

As result of the workshop, the main positive aspect pointed out by the participants was the reduction of costs and optimization of outcomes. This is mostly due to the process speed and nimbleness involving the decision-making and assessment procedures that occur in collaborative and simultaneous ways, avoiding the traditional back and forth movement of paper documents between consultants and public officials responsible for validating each planning step.

On the other hand, the short time assigned for discussions was pointed out as a negative aspect of the workshop dynamics according to the participants, which is contradictory to one of the method's main advantage. This indicates the need to save more time for group work in each of the three iterations. Consequently, the methodological shift toward the use of the Geodesign framework for

Table 5. Comparing the traditional comprehensive planning method and the Geodesign framework applied to PGE and PRU development

Comprehensive Planning Method	Geodesign Framework
Lack of fast updating leading to fast obsolescence of plans	Opens system allowing for simultaneous inputs and outputs
Standardized methodology requiring an extensive inventory	Easily adapted method according to the study area reality
Little integration among planning phases and no feedback	Repeating iterations among phases of why, how, when and where to intervene
Time consuming and expensive: too much emphasis on diagnosis, little time for proposals	Simplified diagnosis reducing time and money consumption
Difficult community engagement on a voluntary basis for such a long period	Simultaneous and collaborative decision-making process with immediate evaluation of alternative solutions and their impacts
Little or no knowledge of goals a projects of a plan by the community	Transparency: a democratization of the planning process
Final products: technical reports	Simple diagrams and easy to understand color coded maps
Final plan oriented	Decision making process oriented

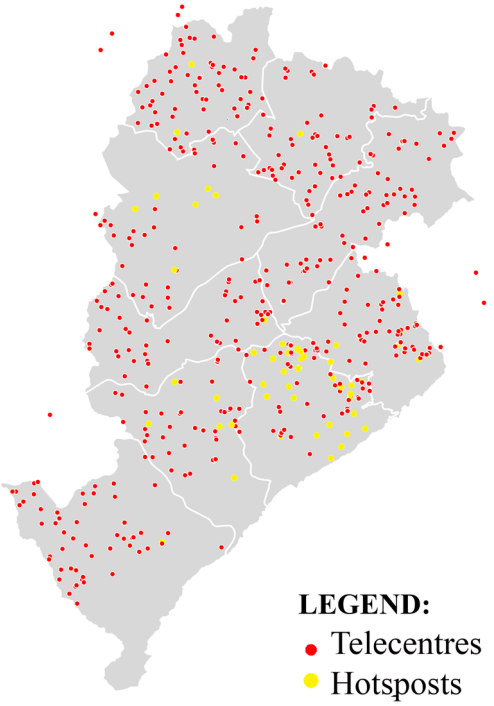
the development of PGE and PRU will potentially increase opportunities and save time and resources used in collaborative tasks as opposed to expensive and time-consuming technical diagnosis, as summarized in Table 5. It's important to highlight that the traditional comprehensive planning method applied to PGE and PRU puts too much emphasis on the final plan whereas Geodesign focuses on the decision-making process. Thus, use of a Geodesign platform may also lead to a more equitable participation among community residents and other stakeholders that take part in the planning process.

According to Campagna (2016), Geodesign provides for a democratic planning environment that is based on the strength and the transparency of information related to choices made during the decision-making process. Collaboration that takes place within a Geodesign framework goes beyond simply information sharing among professionals within a multidisciplinary work. It implies the community's participation in all phases of the planning process, interacting with planners and other stakeholders in very active and diversified ways (Steintz, 2012). This way the quality of the participation process increases even though the quantity of time consumed in participatory events may decrease, also reducing risks of citizens losing interest or becoming absent along the planning process.

As a final remark, it is important to highlight the existence of almost 300 Telecenters[2] in Belo Horizonte, which are free computer and Internet access places located in poor and socially vulnerable communities such as favelas and illegal settlements. Due to the need to have a set of computers connected to a remote server (hub) for a simultaneous visualization of all projects and policies proposed by the different interest groups, free Internet access and computer provision are essential tools for the use of the Geodesign framework.

As community public facilities spread all over the municipal territory (Figure 9), Telecenters have a huge potential to house on-site bottom-up planning workshops for the development of PGE and PRU with an increased level of participation. This strategy can also be a way to reinforce the digital citizenship development component of the Brazilian Digital Inclusion Program which is currently, as many other social policies, threatened by budget cuts, also due to the expansion of smartphones which, in fact, for low income people with little or no free access to broad bandwidth Wi-Fi do not exclude the use of personal computers.

Figure 9. Digital inclusion spaces in Belo Horizonte (Source: Adapted from Belo Horizonte Municipal ICT Authority - Prodabel, 2017



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ENDNOTES

1 Geodesignhub is a software for collaborative geodesign. It enables teams to create and share concepts, to design collaboratively, and to receive change-assessments instantly – all in a highly synergetic, efficient and easy- to- use environment. It is especially effective in the early stages of a complex study or project, when many alternatives must be rapidly created and considered.

2 Telecenters and Hot Spots are part of the digital inclusion public policy infrastructure in Belo Horizonte, as part of the local Digital Inclusion Program – BH Digital. Whereas Telecenters are located in public facilities in socially vulnerable communities, providing free computer, Wi-Fi access, e-government actions and ICT courses for low-income residents, Hotspots are free Wi-Fi areas in public spaces such as main squares and parks.

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